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OLUME 60

# PHYSICS ABSTRACTS

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# Physics Abstracts

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# PHYSICS ABSTRACTS

Volume 60 AUGUST 1957 Number 716

## MATHEMATICS 51

512.3

6799. A LEAST SQUARES SOLUTION OF LINEAR EQUATIONS WITH COEFFICIENTS SUBJECT TO A SPECIAL TYPE OF ERROR. J.K.Mackenzie.
Austral. J. Phys., Vol. 10, No. 1, 103-9 (March, 1957).

Following the classical method a least squares solution is given for the equations

$$\sum_{k=1}^{s} (a_{rk} + e_r b_{rk}) x_k = e_r \quad (r = 1, \ldots, n \geq s),$$

where the $a_{rk}$ and $b_{rk}$ are fixed known constants and the $e_r$ are observed values subject to error. The solution is obtained as a series in the successive moments of the joint distribution of the $e_r$, and only terms up to those involving the variance are retained. In this approximation the estimated values of the $x_k$ are biased, but, after correction for this bias and using a particular weight for each equation, the classical tests of significance for the case $b_{rk} = 0$ can be applied unchanged. With suitable assumptions it is shown that the series converges more and more rapidly as $n \to \infty$ for almost all sequences of the $e_r$. A.

513.813 : 530.12

6800. ON RIEMANNIAN FOUR-DIMENSIONAL SPACES WITH TOTALLY DEGENERATE CURVATURE. R.Debever.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 42, No. 10, 1033-44 (1956). In French.

513.813

6801. A CLASSIFICATION OF EINSTEIN SPACES. J.Géhéniau.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 723-4 (Feb. 4, 1957). In French.

Riemannian 4-spaces for which $R_{ij} = 0$ are divided into seven classes corresponding to certain characteristic forms of the Riemann–Christoffel tensor. R.A.Newing

513.813

6802. THE FOURTEEN INVARIANTS OF CURVATURE OF RIEMANNIAN FOUR-DIMENSIONAL SPACE. J.Géhéniau and R.Debever.
Helv. phys. Acta, Suppl. IV, 101-5 (1956). In French.

"Relativity theory Jubilee" paper (see Abstr. 5818).

513.88
513.88

6803. THE HYPERCIRCLE IN MATHEMATICAL PHYSICS. A METHOD FOR THE APPROXIMATE SOLUTION OF BOUNDARY VALUE PROBLEMS. J.L.Synge.
Cambridge: The Cambridge University Press (1957), 424 pp.

A general account of a method previously applied to special problems (e.g. Abstr. 211/1948). Successive approximations correspond to the end-points of successive steps in function-space to the point which represents the required solution. Thus the solution is located on a hypercircle about that point in function-space and the error is measured by its radius, which provides a simple geometrical approach. Applications include: Dirichlet problems, the torsion problem, other elastic and plastic problems, vibration problems. G.J.Kynch

517.5

6804. COEFFICIENTS FOR "DECOMPOSITION" OF FUNCTIONS INTO LAGUERRE-FUNCTION SERIES. J.W.Head and G.M.Oulton.
Proc. Instn Elect. Engrs, Monogr. 252R, publ. Aug., 1957, 2 pp. To be republished in Part C.

Given a function of time which behaves arbitrarily up to a certain time and is thereafter negligible, a satisfactory 10-term Laguerre-series approximation to the function can in general be written down in terms of the values of the function (obtained by graphical interpolation if necessary) at times proportional to the 10 zeros of the Laguerre function of order 10. The way in which the approximation fails when the procedure is deliberately applied to an unsuitable function is considered. A.

517.512.2 : 621.317.35

6805. THE ANALYSIS OF FINITE-LENGTH RECORDS OF FLUCTUATING SIGNALS. M.J.Tucker.
Brit. J. appl. Phys., Vol. 8, No. 4, 137-42 (April, 1957).

The problem discussed is that of estimating the characteristics of a signal from a record of finite length by Fourier-type analysis or by direct measurement. The paper is an attempt to present the fundamentals of the problem in a coherent form and with the simplest possible mathematics: the results given are not new. The main discussion is of the accuracy of estimates of the power spectra and r.m.s. amplitudes of stationary random Gaussian processes: these have the characteristics of filtered random noise and include a class of signals of great practical importance. The arguments also apply to the problem of estimating the maximum speed with which a signal can be measured and analysed directly. A.

517.6 : 539.172

6806. ($\phi$)-CONVERGENT INTEGRALS AND THEIR APPLICATION TO MATHEMATICAL PHYSICS. P.K.Ghosh.
Bull. Calcutta Math. Soc., Vol. 48, No. 1, 33-44 (March, 1956).

An investigation of some properties of certain infinite integrals which oscillate in the ordinary sense. The integrals have been used to obtain Rutherford's scattering formula, and to evaluate an important integral used by Bethe in the study of the passage of fast particles through matter. L.S.Goddard

518.5 : 621.317.79

6807. A TRIGONOMETRIC ANALOGOUS COMPUTER USING LINEAR ELEMENTS. M.S.M.Abou-Hussein.
J. sci. Instrum., Vol. 34, No. 3, 126-7 (March, 1957).

The basic element of the computer is simply a resistance, R, and capacitor, C, in series across a 1 volt transformer. The voltage across each element is then cos $\phi$ and sin $\phi$ respectively, where $\tan \phi = 1/2\pi f RC$ where f is the supply frequency. The method is developed to yield the other trigonometric functions. A.J.Kennedy

518.5 : 536.461

6808. SOLUTIONS OF A NONLINEAR DIFFERENTIAL EQUATION ARISING IN THE THEORY OF DIFFUSION FLAMES. B.H.Worsley.
Math. Tables Aids Comput., Vol. 9, 112-16 (July, 1955).

The equation is $v'' = Kv(v + x + a - 1)/(x + a)$ and it describes the reaction of sodium vapour diffusing into a halide. It was solved numerically on FERUT at Toronto. Many difficulties of a practical nature were encountered and these are described. A floating-point programme was used. This was written in Transcode, a system of automatic coding developed for FERUT. Graphs of v(x) are given and tables are available. For previous work see R.J.Cvetanovic and D.J.Le Roy, Canad. J. Chem., Vol. 29, 597 (1951). L.S.Goddard

518.61 : 530.162

6809. NUMERICAL SOLUTION OF EQUATIONS OF THE DIFFUSION TYPE WITH DIFFUSIVITY CONCENTRATION-DEPENDENT. II. J.R.Philip.
Austral. J. Phys., Vol. 10, No. 1, 29-42 (March, 1957).

For Pt I, see Abstr. 9446 (1955). A new procedure is developed for the numerical solution of the equation

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x}\left(D\frac{\partial \theta}{\partial x}\right) \frac{\partial K}{\partial x}$$

with D and K single-valued functions of $\theta$ and the conditions $\theta = \theta_n$, $t = 0$, $x > 0$; $\theta = \theta_0$, $x = 0$, $t \geq 0$. Difficulties inherent in the one method previously suggested (see Pt I) are avoided, the problem being reduced to one of solving a set of ordinary differential

equations. The solution is found in a form implicit in $\theta$ and t, with x expressed as a power series in $t^{1/2}$ with the "coefficients" functions of $\theta$ obtained as the solution of the ordinary equations. For problems of interest to the author this series converges rapidly, so that solution of only the first few ordinary equations is needed. A simple and rapid numerical process is given for solving these equations. The truncation error of this process is studied empirically and the convergence of the power series in $t^{1/2}$ examined briefly. A.

# ASTRONOMY . ASTROPHYSICS GEODESY 52

522.61

6810. CONSTRUCTION OF A K-CORONAMETER FOR MEASURING THE BRIGHTNESS OF THE POLARIZED (K) COMPONENT OF THE CORONA. FIRST OBSERVATIONS. G.Wlérick and J.Axtell.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1143-6 (Feb. 25, 1957). In French.

A new type of polarization coronagraph capable of analysing in detail the K component of the solar corona is described in which the residual instrumental polarization is less than $10^{-4}$, and the internal light scatter is also greatly reduced. Successful preliminary trials of a prototype instrument have been made at the High-Altitude Observatory, Boulder, Colorado. D.R.Barber

523.03 : 530.12

6811. OBSERVATIONAL RESULTS ON THE LIGHT DEFLECTION AND ON RED-SHIFT IN STAR SPECTRA. R.J.Trumpler.
Helv. phys. Acta, Suppl. IV, 106-13 (1956).

"Relativity theory Jubilee" paper (see Abstr. 5818). Deflections observed in solar eclipses from 1919 to 1952 are tabulated and are considered to provide confirmation of relativistic theory. Red-shifts are tabulated for eighteen O-type stars taken from 10 galactic clusters. It is suggested that these shifts may be of relativistic origin. R.A.Newing

523.03

6812. RED-SHIFT AND EQUATIONS OF MOTION. A.Papapetrou.
Helv. phys. Acta, Suppl. IV, 116-20 (1956). In German.

"Relativity theory Jubilee" paper (see Abstr. 5818). See also Abstr. 5670 (1956).

523.03 : 537.525

SIMULATION OF ASTROPHYSICAL PROCESSES IN THE LABORATORY. See Abstr. 6217

523.11 : 530.12

6813. COSMOLOGICAL THEORY. H.P.Robertson.
Helv. phys. Acta, Suppl. IV, 128-46 (1956).

"Relativity theory Jubilee" paper (see Abstr. 5818). A class of possible model universes is set up from general geometric and kinematic considerations, and special attention is given to the relationships implied by such models between physical observables such as apparent magnitude and redshift. A survey of redshift data includes most recent observations, which are found to imply decelerated expansion and a Hubble H constant of amount 180 km/sec per Mparsec. For a given value H, relativistic models (with non-zero cosmological constant) form a two-parameter family, and it is concluded that present observations may be represented adequately in terms of such models with reasonable estimates of present density $\rho_0$ and epoch $t_0$. R.A.Newing

523.11

6814. ON COSMOLOGY. M.von Laue.
Helv. phys. Acta, Suppl. IV, 42-3 (1956). In German.

"Relativity theory Jubilee" paper (see Abstr. 5818).

523.11

6815. A WORLD MODEL OF NEWTONIAN COSMOLOGY WITH EXPANSION AND ROTATION. O.Heckmann and E.Schücking.
Helv. phys. Acta, Suppl. IV, 114-15 (1956). In German.

"Relativity theory Jubilee" paper (see Abstr. 5818). See also Abstr. 870 (1956).

523.11

6816. OBSERVATIONAL TESTS IN COSMOLOGY. F.Hoyle.
Helv. phys. Acta, Suppl. IV, 150-1 (1956).

"Relativity theory Jubilee" paper (see Abstr. 5818).

523.11 : 530.12

6817. THE STEADY-STATE THEORY OF COSMOLOGY AND RELATIVITY. H.Bondi.
Helv. phys. Acta, Suppl. IV, 152-4 (1956).

"Relativity theory Jubilee" paper (see Abstr. 5818).

523.112

6818. MACH'S PRINCIPLE AND THE EXPANDING UNIVERSE. A NEW COSMOLOGICAL MODEL. O.Costa de Beauregard.
C.R. Acad. Sci. (Paris), Vol. 244, No. 3, 308-11 (Jan. 14, 1957). In French.

Park's formulation of Mach's principle is shown to be equivalent to a basic principle of Jordan's cosmology and to imply that $\kappa \rho R^2$ is a simple numerical constant. The integration of field equations subject to this condition, and to linear expansion, is considered and it is suggested that the expansion of the universe is associated with the emission of gravitational waves. R.A.Newing

523.112 : 530.145

6819. ON THE DIMENSIONAL INDEPENDENCE OF THE CONSTANTS c, h, $\kappa$, THE PROBLEM OF THE QUANTUM OF LENGTH, AND THOSE OF THE EXPANDING UNIVERSE. O.Costa de Beauregard.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 724-7 (Feb. 4, 1957). In French.

The quantities $l = (\kappa^2 h^2 L/c^2)^{1/5}$, $t = l/c$ and $m = h/cl$ are proposed as natural units of length, time and mass, where L is the "fundamental cosmic length" derived from the recession constant. Implications of a secular variation of the gravitational constant $\kappa$ are discussed. R.A.Newing

523.12

6820. ON THE EDDINGTON RELATIONS AND THEIR POSSIBLE BEARING ON AN EARLY STATE OF THE SYSTEM OF GALAXIES. O.Klein.
Helv. phys. Acta, Suppl. IV, 147-9 (1956).

"Relativity theory Jubilee" paper (see Abstr. 5818). See also Abstr. 9884 (1954).

523.16

6821. ON THE POSSIBILITY OF MEASURING INTERSTELLAR MAGNETIC FIELDS BY 21 cm ZEEMAN SPLITTING. J.G.Bolton and J.P.Wild.
Astrophys. J., Vol. 125, No. 1, 296 (Jan., 1957).

By using a polarization technique analogous to the optical methods of Babcock for weak solar magnetic fields, it should be possible, in the cases where narrow absorption profiles are observed for the 21 cm line, to detect interstellar fields of the order of $10^{-6}$ gauss. M.W.Ovenden

523.164 : 538.566 : 621.396.677

6822. APPLICATION OF MATHEMATICAL THEORIES OF APPROXIMATION TO AERIAL SMOOTHING IN RADIO ASTRONOMY. J.Arsac.
Austral. J. Phys., Vol. 10, No. 1, 16-28 (March, 1957).

An aerial rarely provides a perfect image of a radio brightness distribution. If an array is considered as a filter of "spatial harmonics", the image function is a trigonometric sum approximating the object function. An application of mathematical theories shows the influence of the length and the shape of the array on the difference between object and image. Whatever the array, the image contrasts are bounded. The results provided by various arrays of the same length may be reduced by linear transforms. Inaccuracies of measurement, especially those due to the receiver noise, and to the systematic error due to the finite length of the aerial. One may try to get a compromise between these various causes of uncertainty. A.

523.164.32

6823. CHARACTERISTICS OF A TYPE OF RADIO EMISSION ASSOCIATED WITH CERTAIN CHROMOSPHERIC FLARES. A.Boischot.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1326-9 (March 4, 1957). In French.

Interferometric observations on 169 Mc/s have led to the recognition of a new type of radio emission (type IV) associated with solar flares. The radiation is of long duration, and circularly polarized.

It does not show the bursts characteristic of sunspot radiations, and the apparent diameters of the sources exceed the apparent diameters of sunspots. The centre of emission appears not to be fixed to the solar surface. M.W.Ovenden

523.164.32

6824. OBSERVATION OF SOLAR RADIO-NOISE STORMS WITH THE LARGE INTERFEROMETER AT NANÇAY. Y.Avignon, E.J.Blum, A.Boischot, R.Charvin, M.Ginat and P.Simon.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1460-3 (March 11, 1957). In French.

Daily measures on the sun are used to construct diagrams of evolution of the sources of radio-noise storms, and examine such of their properties as diameter, duration of activity, altitude and circumstances of formation. Each observation is a one-dimensional integration of a strip of the solar image parallel to the local meridian plane and displaced horizontally with time by the diurnal movement. The diagrams of evolution give, for each date, the flux (in units of $10^{-24}$ W m$^{-2}$ per c/s) as a function of position on the disk along an east–west line. The published diagrams, considered as typical, extend over periods of 30 days, and fluxes of more than 20 000 units are recorded. The lower flux limit is 75 units. M.W.Ovenden

523.164.32

6825. AN INTERFEROMETRIC SYSTEM FOR THE STUDY OF LOCALIZED SOLAR SOURCES OF CENTIMETRIC RADIATION. I.Alon, M.R.Kundu and J.L.Steinberg.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1726-9 (March 25, 1957). In French.

Two 2-metre diameter paraboloids are mounted equatorially on a 60 metre east–west line, and used on a wavelength of 3.25 cm. The variation of angular fringe-separation with the hour angle of the source is used to investigate the dimensions and brightness distribution of localized sources on the sun. In general, with persistent sources, at least 75% of the energy is emitted within a region of angular diameter 5'. Observations of sources of bursts are less complete because of their short durations, but angular diameters of the order of 1' are quoted. M.W.Ovenden

523.164.42

6826. DISCRETE SOURCES OF COSMIC RADIO NOISE AT 18.3 AND 10.5 Mc/s. G.R.Ellis and G.Newstead.
J. atmos. terrest. Phys., Vol. 10, No. 4, 185-8 (1957).

Observations of discrete sources at frequencies of 18.3 and 10.5 Mc/s are described. Similar interferometers with a base line of 7 λ were used for detecting the radiation at each frequency. Six sources were observed at both frequencies. Four of the sources were weaker at 10.05 Mc/s than at 18.3 Mc/s and two were stronger. There is an indication that the shape of the low-frequency spectrum of a source is related to its direction. A.

523.77 : 551.521.6

6827. ROCKET OBSERVATION OF X-RAY EMISSION IN A SOLAR FLARE.
T.A.Chubb, H.Friedman, R.W.Kreplin and J.E.Kupperian,Jr.
Nature (London), Vol. 179, 861-2 (April 27, 1957).

Based on the results of high-altitude rocket (Rockoon) flights, some of which were launched during the progress of either Class 1 or Class 2 solar flares, objective evidence is found for the presence of both Lyman-α, and X-radiations that ionize the atmosphere above 70 km, and emanate from the disturbed sun. The Lyman-α line was observed at heights above 67 km, and the X-ray spectrum (~ 3 to 8 A) above 75 km, the respective maximum fluxes being 6.2, and $5.0 \times 10^{-3}$ erg cm$^{-2}$ sec$^{-1}$. D.R.Barber

523.785 : 535.375.55

STRUCTURE OF THE MOTHER SOLUTION OF AN IONIC CRYSTAL. See Abstr. 6037

523.875

6828. SLOW VARIATIONS IN THE SPECTRA OF BRIGHT-LINE O STARS. J.Humblet and G.Mannino.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 42, No. 10, 1045-9 (1956). In French.

Variations of the equivalent widths of the emission lines of He II at 4686 A, and of N III at 4634 and 4640 A, measured on spectrograms of HD 108, HD 34656, HD 188001, HD 190429, HD 190864 and HD 192639 obtained during the years 1941-1956, suggest that a fluorescence mechanism is responsible for the emission by absorption of $Ly_\alpha$ radiation; and that the slow variations with time of the N III lines correspond to the "nitrogen flare stage" found in certain novae. D.R.Barber

529.7

6829. ASTRONOMICAL TIME. G.M.Clemence.
Rev. mod. Phys., Vol. 29, No. 1, 2-8 (Jan., 1957).

A general discussion in which an attempt is made to describe the basic concepts involved in the determination of time in the simplest possible operational terms. Attention is given to the kinematic and dynamic specification of the frame of reference and also to the definition of a clock, which is taken to be a mechanism continually synchronized with ephemeris time. R.A.Newing

# PHYSICS 53

## FUNDAMENTALS 530.1

530.12 : 531.51

6830. THE CLOCK PARADOX AND THE GENERAL THEORY OF RELATIVITY. G.R.Isaak.
Austral. J. Phys., Vol. 10, No. 1, 207-9 (March, 1957).

It is suggested that since the paradox is resolved by the general theory, an experiment (involving unstable charged particles) equivalent to the clock problem would provide a test of general relativity. R.A.Newing

530.12 : 531.31

6831. INTERNAL WORK IN RELATIVISTIC DYNAMICS. G.Marx.
Acta phys. Hungar., Vol. 6, No. 3-4, 353-79 (1957). In German.

Relativistic particle dynamics in Minkowski space–time is generalized to include world forces which are not orthogonal to the world velocity. Scalar fields give rise to the phenomenon of "relativistic repulsion" (see Abstr. 4341/1955) and also to the possibility of particle speeds exceeding that of light. Application to nuclear forces is considered. R.A.Newing

530.12 : 523.841.1

6832. THE GENERAL RELATIVITY FIELD OF A RADIATING STAR. P.C.Vaidya.
Bull. Calcutta Math. Soc., Vol. 47, No. 2, 77-80 (June, 1955).

A non-static solution of the field equations obtained by the author in 1951 represents an expanding zone of radiation immersed in empty space. This solution can be used to describe a nova-type star which starts radiating at time $t_0$, the initial radiation density $\rho_0$ at the surface of the star being non-zero. The solution degenerates into the Schwarzschild pure gravitation field in the case of a "normal" star for which $\rho_0 = 0$, but a generalization of the 1951 solution is applicable to this case. R.A.Newing

530.12

530.12

6833. TETRAD FORMULATION OF GENERAL RELATIVITY THEORY. F.A.E.Pirani.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 2, 143-6 (1957).

An orthonormal tetrad at each point P of space-time specifies a local tangent Minkowski space and defines the 4-velocity and local Cartesian frame of an observer at P. The tetrad formulation facilitates the physical interpretation of results in general relativity. An illustrative application is given in a discussion of Papapetrou's spinning test particle. R.A.Newing

530.12

6834. ALGEBRAIC STUDY OF A METRIC TENSOR AND A GENERAL ELECTROMAGNETIC FIELD IN THE EINSTEIN–SCHRÖDINGER UNIFIED THEORY. S.Mavridès.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1149-51 (Feb. 25, 1957). In French.

530.12

6835. BASIS OF A UNIFIED THEORY USING AFFINE FIBRE SPACE. M.Lenoir.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1151-3 (Feb. 25, 1957). In French.

530.12 : 530.145

6836. GENERALISATIONS OF EINSTEIN'S THEORY OF GRAVITATION CONSIDERED FROM THE POINT OF VIEW OF QUANTUM FIELD THEORY. O.Klein.
Helv. phys. Acta, Suppl. IV, 58-71 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818). The possible extension of the author's five-dimensional theory of combined gravitational and electromagnetic fields to include quantum fields is discussed, and it is suggested that a rigorous consideration of gravitational effects may eliminate the divergences of electron theory. A sketch is given of a possible theory involving states of multiple charge. R.A.Newing

530.12

6837. A TIME-KEEPING PROBLEM CONNECTED WITH THE GRAVITATIONAL RED-SHIFT. W.H.McCrea.
Helv. phys. Acta, Suppl. IV, 121-4 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818). It is shown that a particle-clock which describes a circular orbit in a central gravitational field appears to go slow as compared with a similar clock at a greater orbital distance. The factor appearing in the comparison can be interpreted by a combination of the effects concerned in the gravitational red-shift and in the clock-paradox. A.

530.12

6838. GRAVITATIONAL WAVES. N.Rosen.
Helv. phys. Acta, Suppl. IV, 171-5 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818). A discussion of cylindrical waves supports the conjecture that physical systems cannot radiate gravitational energy. R.A.Newing

530.12

6839. GENERAL PROBLEMS OF INTEGRATION OF RELATIVISTIC EQUATIONS. A.Lichnerowicz.
Helv. phys. Acta, Suppl. IV, 176-91 (1956). In French.
"Relativity theory Jubilee" paper (see Abstr. 5818). A review of the author's mathematical investigations of the field equations of the general and unified theories includes a discussion of Cauchy problems and of existence and uniqueness theorems. R.A.Newing

530.12

6840. ON THE DEFINITION OF INERTIAL SYSTEMS IN GENERAL RELATIVITY. F.A.E.Pirani.
Helv. phys. Acta, Suppl. IV, 198-203 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818). In a general discussion it is suggested that the parallel transport of the local reference frame of a freely falling observer would provide a local frame in which Newton's laws are approximately valid. Fermi propagation might replace parallel propagation if the observer's orbit is not a geodesic. R.A.Newing

530.12

6841. MATHEMATICAL STRUCTURE OF THE NON-SYMMETRIC FIELD THEORY. B.Kaufman.
Helv. phys. Acta, Suppl. IV, 227-38 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818). A new presentation of Einstein's unified theory in which emphasis is placed on the "displacement field" $\Gamma^s_{ik}$. The theory is developed in terms of the variables $U^s_{ik} \equiv \Gamma^s_{ik} - \delta^s_k \Gamma^j_{ij}$ and the requirement of "transposition symmetry" $M^{\cdots}_{\cdots k \cdots i \cdots}(U) = M^{\cdots}_{\cdots i \cdots k \cdots}(\tilde{U})$ is introduced, where $\tilde{U}^s_{ik} = U^s_{ki}$. R.A.Newing

530.12

6842. THE SPACE-TIME OF THE THEORY OF RELATIVITY. A.Alexandrov.
Helv. phys. Acta, Suppl. IV, 44-5 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12

6843. HOMOGENEOUS AND ISOTROPIC SPACES IN RELATIVITY. J.Tits.
Helv. phys. Acta, Suppl. IV, 46-7 (1956). In French.
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12 : 513

6844. ON THE RELATION BETWEEN GEOMETRY AND PHYSICS AND THE CONCEPT OF SPACE-TIME. D.van Dantzig.
Helv. phys. Acta, Suppl. IV, 48-53 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12

6845. THE IDEAL STANDARD CLOCKS IN THE GENERAL THEORY OF RELATIVITY. C.Møller.
Helv. phys. Acta, Suppl. IV, 54-7 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12

6846. CAUCHY'S PROBLEM IN THE RELATIVISTIC THEORY OF ELECTROMAGNETISM AND IN THE JORDAN–THIRY UNIFIED THEORY. Y.Fourès-Bruhat.
Helv. phys. Acta, Suppl. IV, 76-8 (1956). In French.
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12

6847. COMPLEMENTARITY AND RELATIVITY. O.Costa de Beauregard.
Helv. phys. Acta, Suppl. IV, 99-100 (1956). In French.
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12

6848. ON THE TWO-BODY PROBLEM OF GENERAL RELATIVITY. E.Corinaldesi.
Helv. phys. Acta, Suppl. IV, 125-7 (1956).
"Relativity theory Jubilee" paper (see Abstr. 5818). See also Abstr. 5675 (1956).

530.12

6849. ON THE HYPOTHESIS OF A VARIABILITY OF THE SO-CALLED GRAVITATION CONSTANT. P.Jordan.
Helv. phys. Acta, Suppl. IV, 157-67 (1956). In German.
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12

6850. JORDAN'S THEORY OF GRAVITATION WITH NEW FIELD EQUATIONS. G.Ludwig and K.Just.
Helv. phys. Acta, Suppl. IV, 168-70 (1956). In German.
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12

6851. THE GENERAL SOLUTION OF EINSTEIN'S EQUATIONS $g_{\underset{+}{\mu}\underset{-}{\nu};\rho} = 0$. M.Tonnelat.

Helv. phys. Acta, Suppl. IV, 192-7 (1956). In French.
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.12

6852. ON THE EXISTENCE CONDITIONS FOR THE SOLUTION OF $g_{\underset{+}{\mu}\underset{-}{\nu};\rho} = 0$. S.Kichenassamy.

C.R.Acad. Sci. (Paris), Vol. 244, No. 2, 168-70 (Jan. 7, 1957). In French.
Tonnelat's solution (Abstr. 2394/1955) is found to be more general than that due to Hlavatý (J. rational Mech. Anal., Vol. 2, 1 and 523, 1953). R.A.Newing

530.12

6853. ON A PARTICULAR CASE OF THE SOLUTION OF $g_{\underset{+}{\mu}\underset{-}{\nu};\rho} = 0$. S.Kichenassamy.

C.R. Acad. Sci. (Paris), Vol. 244, No. 15, 2007-9 (April 8, 1957). In French.

530.12

6854. ON THE MOVEMENT OF ROTATING BODIES ACCORDING TO EINSTEIN'S THEORY OF GRAVITATION. V.Fock (Fok).
Helv. phys. Acta, Suppl. IV, 204-5 (1956). In French.
"Relativity Theory Jubilee" paper (see Abstr. 5818).

530.12

6855. ON EQUATIONS OF MOTION IN GENERAL RELATIVITY THEORY. L.Infeld.
Helv. phys. Acta, Suppl. IV, 206-9 (1956).
"Relativity Theory Jubilee" paper (see Abstr. 5818).

530.12

6856. ON SYSTEMS OF PREFERRED COORDINATES IN EINSTEIN'S THEORY OF GRAVITATION. V.Fock (Fok).
Helv. phys. Acta, Suppl. IV, 239-43 (1956). In French.
"Relativity theory Jubilee" paper (See Abstr. 5818).

530.12

6857. PHYSICS AND RELATIVITY. M.Born.
Helv. phys. Acta, Suppl. IV, 244-60 (1956).
"Relativity Theory Jubilee" paper (see Abstr. 5818). Historical reminiscences.

530.12

6858. RELATIVISTIC AGEING. W.H.McCrea.
Nature (London), Vol. 179, 909-10 (May 4, 1957).
In a qualitative discussion it is suggested that the properties of relativistic ageing might be summed up as an impotence principle "It is impossible by any departure from free motion to improve our ability to predict the consequences of a physical experiment." It is also noted that asymmetric ageing is consistent with thermodynamical principles. R.A.Newing

530.12

6859. ON A SOLUTION OF FIELD EQUATIONS IN EINSTEIN'S UNIFIED FIELD THEORY. I. N.N.Ghosh.
Progr. theor. Phys., Vol. 16, No. 5, 421-8 (Nov., 1956).

Deals with the general solution of field equations (in the "strong" form) corresponding to a non-symmetric tensor field $g_{\mu\nu}$ whose symmetric components s and anti-symmetric components a are expressed by using general indices k, m, n, l instead of 1, 2, 3, 4. The components $s_{kk}$, $s_{ll}$, $a_{kl}$ are taken to be functions of $x_k$ while $s_{mm}$, $s_{nn}$, $a_{mn}$ are each expressible as product of a function of $x_k$ and $x_m$. In the process of solution of the relevant field equations there appears a parameter $\lambda$ in an auxiliary equation which can take negative, positive or zero values. It is found that the usual spherically symmetric solutions considered by Bonnor result when $\lambda$ is negative. The other two types of solution are also noted in this connection and a particular case not considered by Bonnor is also discussed. A.

530.12

6860. THE EQUATIONS OF MOTION IN THE SINGLE FIELD-FUNCTION THEORY OF THE GRAVITATIONAL FIELD. H.J.Meister.
Z. Phys., Vol. 147, No. 5, 531-43 (1957). In German.

A second order approximation to the equations of motion for a double star system is obtained for Papapetrou's single function theory (Abstr. 2391/1955). It is found that, for systems whose components are of comparable mass, the periastron motion is smaller than than given by the general theory, but the two theories agree in the limiting case of planetary motion around the sun. R.A.Newing

530.12 : 530.145

6861. ON "STRONG" AND "QUASI-STRONG" CONSERVATION LAWS OF GENERAL COVARIANT FIELD THEORY AND THEIR GENERAL DIFFERENTIAL IDENTITIES. W.R.Davis.
Z. Phys., Vol. 148, No. 1, 1-14 (1957). In German.

The general theory considered is defined by a variation principle for which the density function depends upon two field variables with different transformation laws. An illustrative application of the results established is made to Einstein's unified theory. R.A.Newing

530.12

6862. NON-STATIC SPHERICALLY SYMMETRIC SOLUTIONS OF THE VACUUM FIELD EQUATIONS IN [JORDAN'S] EXTENDED THEORY OF GRAVITATION. E.Schücking.
Z. Phys., Vol. 148, No. 1, 72-92 (1957). In German.

It is noted that the Schwarzschild static solution follows in the case of spherical symmetry when $\kappa = 0$, and also in the special case $\kappa_{|j}\kappa^{|j} = 0$, where $\kappa$ is the coefficient of gravitation. Non-static homogeneous solutions are obtained for which $\kappa$ and the time and radial components of the metric tensor are functions of (r/t). Particular inhomogeneous non-static solutions are also obtained. R.A.Newing

530.12

6863. ON THE INTERPRETATION OF FIVE-DIMENSIONAL FIELD EQUATIONS. J.Petzold.
Z. Phys., Vol. 148, No. 2, 192-208 (1957). In German.

Field equations are formulated in a 5-space $X^\mu$ whose metric is not necessarily symmetric and the transition to 4-space $x^A$ is made by the use of the pentad

$$g^\mu_A = \frac{\partial X^\mu}{\partial x^A} + \lambda_A \frac{\partial X^\mu}{\partial x^0}, \quad g^\mu_0 = \lambda_0 \frac{\partial X^\mu}{\partial x^0},$$

where $\lambda_A$ and $\lambda_0$ are respectively a vector and scalar in 4-space. The physical significance of the field equations in 4-space depends upon the choice made for $\lambda_k$. The general theory includes projective relativity and Hoffmann's vector meson field theory as special cases. Difficulties arising in an attempted projective extension of Einstein's unified theory are noted, but it is found possible to interpret the case of a non-symmetric metric as a generalized Proca vector meson field. R.A.Newing

530.145 : 539.18 : 539.165.2

THE QUESTION OF TIME REVERSAL INVARIANCE OF WEAK INTERACTIONS. See Abstr. 6508, 6595

530.145

6864. ON A FURTHER MODIFICATION OF DIRAC'S δ-FUNCTIONS. L.Infeld and J.Plebański.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 1, 51-4 (1957).

The authors extend their previous work (Abstr. 5023/1957). P.M.Davidson

530.145

6865. ON THE CONSERVATION THEOREMS AND EQUATIONS OF MOTION IN COVARIANT FIELD THEORIES. A.Trautman.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 4, No. 10, 675-8 (1956).

This paper starts with a Lagrangian depending on the components and first derivatives of the metric tensor and a tensor field $\psi$. The aim is to obtain a conservation law for the $\psi$-field, and to derive the equations of motion for a "cluster of particles" moving in such a field. The latter problem is closely related to a paper by Infeld on the equations of motion in linear field theories (Abstr. 7678/1955). W.A.Hepner

530.145

6866. KILLING'S EQUATIONS AND CONSERVATION THEOREMS. A.Trautman.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 4, No. 10, 679-82 (1956).

Following previous paper (see preceding abstract) the relation between covariance, metric and conservation laws is considered. W.A.Hepner

530.145

6867. CONTINUOUS VECTOR FIELDS IN LINEAR FIELD THEORY. W.Scherrer.
Helv. phys. Acta, Suppl. IV, 155-6 (1956). In German.

"Relativity theory Jubilee" paper (see Abstr. 5818).

530.145

6868. HAMILTONIAN FORMALISM AND ENERGY-MOMENTUM TENSOR WITH DIFFERENTIAL CONSERVATION LAW FOR NON-LOCAL FIELD THEORIES. W.Weidlich.
Z. Phys., Vol. 147, No. 3, 288-96 (1957). In German.

Starting from a Lagrangian principle for non-local fields and passing to the Hamiltonian formalism, quantization of the canonically conjugate variables leads, in the case of higher-order equations, to a regularized theory (Abstr. 47/1950). It is also shown that, using the formalism of general relativity, a symmetric energy-momentum tensor with vanishing divergence can be obtained. W.A.Hepner

530.145

6869. THE QUANTIZATION OF ANGULAR MOMENTUM DEDUCED FROM THE THEORY OF QUADRUPLE FIELDS. A.Aymard.
C.R. Acad. Sci. (Paris), Vol. 244, No. 3, 312-13 (Jan. 14, 1957). In French.

The theory is shown to imply quantization in the case of stationary axially symmetric fields. R.A.Newing

530.145 : 530.12

6870. QUANTIZATION OF GENERAL COVARIANT FIELD THEORIES. P.G.Bergmann.
Helv. phys. Acta, Suppl. IV, 79-97 (1956). In German.

"Relativity theory Jubilee" paper (see Abstr. 5818). In this review paper, the canonical formulation of field theories covariant with respect to general coordinate transformations is discussed, and the problem of quantization is considered with special reference to the introduction of "true observables". Brief consideration is also given to spin and angular momentum in general relativity and to the role of strong conservation laws. R.A.Newing

530.145

6871. REMARKS ON THE "NEW TAMM–DANCOFF METHOD" IN THE QUANTUM THEORY OF FIELDS. W.Heisenberg.
Nachr. Akad. Wiss. Göttingen, Math.-Phys. Kl.IIa, No. 3, 27-36 (1956). In German.

Using the model of the anharmonic oscillator, it is shown how the "contravariant" representation introduced by Nishijima (Abstr. 5305/1954) can be obtained from the usual covariant representation, so that the normalization can be achieved. The procedure is applied to the author's non-linear field theory, and yields useful information, e.g., about the density distribution in an elementary particle. W.A.Hepner

530.145

6872. BOSON FAMILY FROM QUANTIZED FINITE-PARTICLE MAXWELL THEORY. R.Ingraham and J.Ford.
Phys. Rev., Vol. 106, No. 6, 1324-6 (June 15, 1957).

Quantization of finite-particle Maxwell theory yields a family of free bosons of nonzero masses and spins 1 and 0. The existence of a mass spectrum is a direct consequence of the new degree of freedom $\lambda$ of particle size. These are quanta of short-range (meson) forces. The force-free theory (i.e., uncoupled to a fermion field) is studied here as a preliminary to be coupled case. An automatic connection with the Pauli–Villars regulator theory is obtained. The nature and position of the singularities in the field commutators of quantum electrodynamics and meson theory is profoundly altered. A.

530.145

6873. THE CREATION OF AN ELECTRON PAIR BY A FAST CHARGED PARTICLE. T.Murota, A.Ueda and H.Tanaka.
Progr. theor. Phys., Vol. 16, No. 5, 482-96 (Nov., 1956).

Using a Feynman–Dyson method, the cross-section for the creation of an electron pair by a fast charged particle is calculated but in a manner more precise than that of Bhabha and others. The differential cross-section obtained is valid as long as the energies of participant particles are large compared with the respective rest masses. The ambiguities in Bhabha's calculation are also examined. It is concluded that the theoretical value must be compared with the experimental results produced by high-energy electrons ($\geq 10$ BeV). A.
530.145 : 539.18

6874. GENERALIZATION OF THE METHOD OF WILLIAMS AND WEIZÄCKER. P.Kessler and D.Kessler.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1896-8 (April 1, 1957). In French.

Previous work (Abstr. 7136/1956) is extended to allow the energy transfer to be comparable with the primary energy, for example in the production of energetic showers by cosmic-ray muons. J.S.Bell
530.145 : 539.18

6875. AN ATTEMPT OF GENERALIZING THE HYPOTHESIS OF CHARGE INDEPENDENCE. O.Hara and Y.Fujii.
Progr. theor. Phys., Vol. 16, No. 2, 149-50 (Aug., 1956).

Angular momenta $\vec{I}$, $\vec{J}$, $\vec{K}$, and $\vec{L}$ are introduced in charge space, such that $\vec{L} = \vec{I} + \vec{J} + \vec{K}$, where $\vec{I}$ is the usual isotopic spin, and $eL_3$, $2J_3$ and $2K_3$ are the electric charge, strangeness, and baryon number, respectively ($\vec{K} = 0$ for bosons). It is assumed that $(\vec{I} + \vec{J})$ is conserved in interactions not involving the electromagnetic field, and that $\vec{I}$ and $\vec{J}$ are separately conserved in strong interactions. The resulting predictions of hyperon and heavy meson branching and lifetime ratios are the same as those obtained using the rule $\Delta I = \frac{1}{2}$ proposed by other authors. J.W.G.Wignall
530.145 : 539.18

6876. A CONJECTURE ON THE POSSIBLE EXISTENCE OF NEW HYPERONS. O.Hara and Y.Fujii.
Progr. theor. Phys., Vol. 16, No. 2, 150-2 (Aug., 1956).

On the basis of the authors' theory (see preceding abstract) a spectrum of hyperon masses and charge states is proposed. Classifications in this scheme of the events observed by Eisenberg and by Fry et al. are suggested. J.W.G.Wignall
530.145

6877. ON THE FOUNDATION AND THE APPLICABILITY OF WILLIAMS–WEIZSÄCKER METHOD. T.Murota and A.Ueda.
Progr. theor. Phys., Vol. 16, No. 5, 497-506 (Nov., 1956).

The energy spectrum of the virtual photon field accompanied by a high-energy charged particle which has been derived classically by Williams and Weizsäcker independently is derived here by the Feynman–Dyson method, and the equivalence between the Williams–Weizsäcker and the Feynman–Dyson methods is verified in a general way when the energy transferred from an incident charged particle is small. It is also qualitatively shown that the cross-section derived by the Williams–Weizsäcker method gives a correct order of magnitude. A.
530.145

6878. ON A MODIFIED HULTHÉN POTENTIAL. S.G.M.Gustavi.
Ark. Fys., Vol. 11, Paper 37, 437-43 (1957).

For the S-state of the deuteron system the wave equation with the potential $-V_0[\exp(-\mu r)][1 - \exp(-\mu r)]^{-2}$ can be transformed into a hypergeometric equation. The discussion of the bound-state problem leads to the distinction between under- and overcritical potentials depending on whether $(M/\hbar^2)(V_0/\mu^2) \leq \frac{1}{4}$ or $> \frac{1}{4}$. In the latter case the oscillations of the wave-function become infinite as $r \to 0$. In both cases the wave-functions are still singular at the origin. Then the low-energy scattering solutions are derived and an asymptotic expression for the zero energy wave-function for $r \to \infty$ is obtained. The physical consequences are: the overcritical potential must be used with a cut-off; for the undercritical potential there exist no bound states if it is required that the singularity in the wave-function at the origin disappears with the potential, and for the scattering the effective range is much too large compared with the observed one. F.Ansbacher
530.145

6879. THE EQUATIONS OF MOTION OF THE POLE–DIPOLE PARTICLE. K.Nagy.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 4, No. 10, 683-5 (1956). In German.

The equations of motion are set up, using the method of Infeld. P.M.Davidson
530.145

6880. ON DIRAC SPINORS WITH INVARIANT COMPONENTS. J.Winogradzki.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1158-60 (Feb. 25, 1957). In French.

A discussion of second rank spinors whose components are invariant with respect to the group of reversals, or to the orthochronous or general Lorentz groups. It is suggested that the results may provide a natural classification of first rank spinors of relevance to the theory of spin $\frac{1}{2}$ particles. R.A.Newing
530.145 : 531.51 : 535.1

6881. COMPOSITE PARTICLES OF ZERO MASS. K.M.Case.
Phys. Rev., Vol. 106, No. 6, 1316-20 (June 15, 1957).

A neutrino theory of spin-zero particles of zero mass is constructed in terms of bilinear neutrino operators. The restrictions of a two-component neutrino theory are shown to reduce the possible fields from three to one. Further, by using a two-component neutrino theory it is shown that it is impossible by using bilinear expressions to form a theory of light and that using quadrilinear expressions cannot produce a theory of gravitation. A.
530.145

6882. A VARIATION–ITERATION METHOD FOR SHORT RANGE POTENTIAL PROBLEMS. J.Irving and F.B.Boucher.
Proc. Phys. Soc. A, Vol. 70, Pt 7, 512-14 (July, 1957).

The device of cutting off the potential at a point where the asymptotic form of the wave-function is valid permits the use of a simple trial wave-function in the form of a polynomial in which some of the coefficients are variation parameters. The variation–iteration method is thereby simplified. As an illustration the bound-state deuteron problem is solved for a central Yukawa interaction and the results compared with those obtained by other authors. A.
530.145

6883. ON THE BETHE–SALPETER EQUATION FOR THE SCALAR–SPINOR PARTICLE SYSTEM.
R.Sugano and Y.Munakata.
Progr. theor. Phys., Vol. 16, No. 5, 532-4 (Nov., 1956).

Comparison with the results for the scalar–scalar and spinor–spinor systems. W.A.Hepner
530.145

6884. ON A COMPOSITE MODEL FOR THE NEW PARTICLES. S.Sakata.
Progr. theor. Phys., Vol. 16, No. 6, 686-8 (Dec., 1956).

The hypothesis that the new unstable particles are composed of four "fundamental" particles (viz. n, $\Lambda^0$ and their antiparticles) is put forward to account for the rule of Nishijima and Gell-Mann as a consequence of the addition laws for ordinary and isotopic spin and for strangeness. W.A.Hepner
530.145

6885. ON THE STRUCTURE OF NUCLEONS. I.E.Tamm
Zh. éksper. teor. Fiz., Vol. 32, No. 1, 178-80 (1957). In Russian.

The seeming paradox between the large radius of the proton, as determined from electron scattering, and the weak interaction of neutrons with electrons can be resolved if one considers that the $\pi$-meson interacts strongly with nucleon pairs. Then the $\pi$-meson is dissociated much of the time into a nucleon pair, and the charge distribution of the pairs is spread over the same distance as the meson cloud. G.E.Brown
530.145

6886. COMPLETE SYSTEM OF INTEGRAL EQUATIONS OF THE LOW TYPE. R.Omnès.
C.R. Acad. Sci. (Paris), Vol. 244, No. 1, 47-9 (Jan. 2, 1957). In French.

Integral equations for the collision matrix elements $T_{p_1 p_2 p_3 \ldots p_r}(q_1 q_2 q_3 \ldots q_s)$ between r initial mesons completely characterized by the respective p's and s final mesons similarly characterized by the q's are given. The special case r = 1, s = 1 corresponds to the equation given by Low (Abstr. 3453/1955) and the case r = 1, s = 2 to that given by the author in Abstr. 5062 (1957). H.Motz
530.145

6887. DETERMINATION OF A SEPARABLE POTENTIAL FROM THE PHASE SHIFTS. SHAPE INDEPENDENT APPROXIMATION. M.Gourdin and A.Martin.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1153-4 (Feb. 25, 1957). In French.

The problem of determining a separable neutron–proton potential to give prescribed S-wave phase-shifts is considered. Supposing the phase shifts to be given exactly by the usual effective-range formula, a unique solution is found for the singlet state, and a solution with one parameter for the triplet state. J.S.Bell

530.145

6888. DETERMINATION OF A SEPARABLE POTENTIAL FROM THE PHASE SHIFTS. CASE WHERE TAN δ IS A RATIONAL FRACTION OF THE ENERGY. M.Gourdin and A.Martin.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1329-30 (March 4, 1957). In French.

The results of the preceding abstract are generalized. As in the case of local potentials, the solution is found to be unique when there are no bound states, and to contain one parameter when there is one bound state. J.S.Bell

530.145

6889. DETERMINATION OF A SEPARABLE POTENTIAL FROM THE PHASE SHIFTS. GENERAL THEOREMS. M.Gourdin and A.Martin.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1469-70 (March 11, 1957). In French.

See the two preceding abstracts. Assuming the phase shift to satisfy certain very general physical conditions, the maximum number of independent solutions is found. The uniqueness is shown of the solutions already obtained for special cases. J.S.Bell

530.145 : 537.533.74

6890. ELECTROMAGNETIC SCATTERING OF PARTICLES WITH A STRUCTURE. M.Fabre de la Ripelle.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1161-3 (Feb. 25, 1957). In French.

It is assumed that the electron has an electromagnetic structure similar to that found for the proton. The electron–electron scattering is then treated by a natural extension of the usual theory. It is found that the structure has the effect of multiplying the matrix element calculated for point particles by the product of the squares of the Fourier transforms of the structures. For scattering by electrons at rest the effect becomes appreciable only at energies of ~40 BeV; in the case of the interaction of two electron beams this minimum energy is several $10^7$ eV. L.Pincherle

530.145

6891. BOSE–EINSTEIN GAS WITH REPULSIVE INTERACTIONS. GENERAL THEORY. K.A.Brueckner and K.Sawada.
Phys. Rev., Vol. 106, No. 6, 1117-27 (June 15, 1957).

The properties of a Bose–Einstein gas with repulsive interparticle interactions are determined at low temperature. It is shown that the contribution to the energy arising from particle excitation with small momentum transfers computed in conventional perturbation theory is divergent, but that this difficulty can be avoided by an alternative procedure. An exact method is developed for dealing with that part of the Hamiltonian which gives rise to the perturbation divergence and an exact solution is obtained. The treatment of the region of large momentum transfers is then carried out by introducing the concept of the scattering length of the interaction. The energy is given by the well-known result of the optical theorem corrected by a series in powers of $(\rho a^3)^{1/2}$, where $\rho$ is the density and a the scattering length. Examination of the processes contributing to the energy shows that 95.8% of the correction of order $(\rho a^3)^{1/2}$ results from a simple alteration of the perturbation energy demoninators which takes into account the interaction energy of excited pairs with the unexcited pairs of the medium. The remaining 4.2% arises from multiple particle excitation. These methods also predict the existence of phonon excitation with phonon energies that are linear in the phonon momentum for small excitation and approach $q^2/2M$ for large momentum. The detailed consideration of this spectrum forms part of the following paper. The results are compared with the theory of fermion systems with strong interactions, where again the largest correction to the first-order "optical" energy arises from alteration of the two-particle propagator which is required to take into account interactions with the many unexcited particles of the medium. The propagator corrections in the fermion and boson systems are similar except for a characteristic difference arising from the statistics. The theory for bosons is shown to be essentially identical with that given by Brueckner and Levinson in their general formulation of the theory of many-body systems with strong interactions. Systems with attractive but saturating interactions are also considered and some new difficulties are shown to arise which cannot be treated by a straightforward application of the methods of this paper. A.

530.145

6892. BOSE–EINSTEIN GAS WITH REPULSIVE INTERACTIONS. HARD SPHERES AT HIGH DENSITY. K.A.Brueckner and K.Sawada.
Phys. Rev., Vol. 106, No. 6, 1128-35 (June 15, 1957).

A method developed by the authors (see preceding abstract) for treating Bose–Einstein particles at low temperature is specialized to the case of hard-sphere interactions. It is shown that the integral equations determining the energy can in this case be replaced by an integral involving the unknown excitation spectrum. The energy is first determined as a power series in $(\rho a^3)^{1/2}$, where $\rho$ is the density and a the hard-sphere radius. This solution is shown to diverge badly at high density. A result is then obtained which is valid over the full range of density, reducing to the exact expressions at low density and to a good approximation at high density. The excitation spectrum of the system is shown to have a peculiar nonmonotonic relation between energy and momentum very similar to that deduced by Landau from the low-temperature properties of $He^4$. A.

530.145

6893. EIGENVALUES AND EIGENFUNCTIONS OF A BOSE SYSTEM OF HARD SPHERES AND ITS LOW-TEMPERATURE PROPERTIES. T.D.Lee, K.Huang and C.N.Yang.
Phys. Rev., Vol. 106, No. 6, 1135-45 (June 15, 1957).

It is shown that the pseudopotential method can be used for an explicit calculation of the first few terms in an expansion in power of $(\rho a^3)^{1/2}$ of the eigenvalues and the corresponding eigenfunctions of a system of Bose particles with hard-sphere interaction. The low-temperature properties of the system are discussed. A.

530.145 : 537.533.74

6894. A BOX VARIATIONAL METHOD FOR SCATTERING PHASES. I.C.Percival.
Proc. Phys. Soc. A, Vol. 70, Pt 7, 494-500 (July, 1957).

The paper presents a variational method for calculating elastic s-wave scattering phases for short-range potentials, based on the Rayleigh–Ritz method for discrete energy levels, in which the approximate phase approaches the exact phase from below. The method is applied to scattering of electrons by the static field of the hydrogen atom. A.

530.145 : 539.172

6895. NATURE OF NUCLEAR FORCES INDICATED BY THE PHOTODISINTEGRATION OF THE DEUTERON. II. S.H.Hsieh.
Progr. theor. Phys., Vol. 16, No. 1, 68-70 (July, 1956).

For Pt I, see Abstr. 719 (1957). To account for the large isotropic part of the cross-section for the photodisintegration of the deuteron and p–p scattering, it is necessary to adopt a smaller value of the scattering phase shift $\delta_0^0$ and larger values of $\delta_1^0$, $\delta_1^1$ and $\delta_1^2$ than hitherto. J.W.Sturgess

530.145

6896. TWO-NUCLEON PROBLEM WITH PION THEORETICAL POTENTIAL. I. DETERMINATION OF COUPLING CONSTANT AND DEUTERON PROBLEM.
J.Iwadare, S.Otsuki, R.Tamagaki and W.Watari.
Progr. theor. Phys., Vol. 16, No. 5, 455-71 (Nov., 1956).

Assuming the pion theoretical potential due to the exchange of one pion in the region outside the pion Compton wavelength, the deuteron problem is analysed. Since the deuteron has a large radius on account of its small binding energy, the wave-function is strongly affected by the outer part of the potential. This outer part of the pion theoretical potential has the effective coupling constant $g_e^2/4\pi$ between the p-wave pion field and a nucleon as the only variable parameter. Thus the value of the coupling constant can be determined from the deuteron problem as $0.065 < g_e^2/4\pi < 0.090$. This value is in good agreement with that inferred from pion reactions. The form of the deuteron wave-function with the pion theoretical potential and its approximate analytical expression are given. It is found that the tensor potential must be negative inside the pion Compton wavelength in order to give the bound deuteron state, which is consistent with the pion theoretical potential in the same region. A.

530.145

6897. TWO-NUCLEON PROBLEM WITH PION THEORETICAL POTENTIAL. II. SINGLET EVEN STATE.
J.Iwadare, S.Otsuki, R.Tamagaki and W.Watari.
Progr. theor. Phys., Vol. 16, No. 5, 472-81 (Nov., 1956).

Low energy parameters in the singlet even state are analysed from the point of view of the pion theory. It is shown that the properties which are required for the potential in the singlet even state are as follows: The one-pion-exchange potential in the outer region, a strong attractive force in the region from the pion range to one half of it, which is consistent with the prediction by the two-pion-exchange potential, and a strong repulsion at small distances at least up to x = 0.20. The value of the effective coupling constant of the one-pion-exchange potential is limited as $g_e^2/4\pi > 0.07$ by the present analysis. This result, together with that of the Pt I, gives an allowed region for the coupling constant as $0.07 < g_e^2/4\pi < 0.09$. A.

530.145

6898. TWO-NUCLEON PROBLEM WITH PION THEORETICAL POTENTIAL. III. p–p SCATTERING AT 18.2 MeV.
J.Iwadare, S.Otsuki, R.Tamagaki and W.Watari.
Progr. theor. Phys., Vol. 16, No. 6, 604-12 (Dec., 1956).

A p–p scattering experiment at 18 MeV is analysed from the point of view of pion theory. The pion theoretical potential, which is consistent with all low energy phenomena, gives a precise fit to the experimental data at 18 MeV. Especially, it is found that in the triplet odd state an attractive central potential around the pion range is required from the experimental data. This attractive potential is consistent with the two-pion-exchange potential. A.

530.145

6899. ON AN EXTENDED FRAMEWORK FOR THE DESCRIPTION OF ELEMENTARY PARTICLES.
M.Ikeda and Y.Miyachi.
Progr. theor. Phys., Vol. 16, No. 6, 537-47 (Dec., 1956).

An attempt is put forward to formulate as exactly as possible the basic assumption proposed by Pais in his $\omega$-space theory, and a wider framework for the description of elementary particles is obtained which involves that of Pais as a special case. It is found necessary to introduce some field which characterizes the structure of the total manifold. The b field equations introduced by Yang and Mills give one of the admissible forms of the field equations for this new field. Finally the b field is compared with the electromagnetic and the gravitational fields, and similarities and dissimilarities between them are pointed out. A.

530.145

6900. MESON–NUCLEON SCATTERING IN LOW ENERGY REGION. D.Itô and S.Minami.
Progr. theor. Phys., Vol. 16, No. 6, 548-54 (Dec., 1956).

The scattering length a for the s-wave of the process $\pi^+ + p \rightarrow \pi^+ + p$ is calculated by tracing the experimental data for $\alpha_3$. Comparing the value of $4\pi a^2$ with the theoretical value of cross-section in the Thomson limit, it is found that the coupling constant $f^2/4\pi$ is nearly equal to 1. Because of the importance of meson–meson interaction inferred from the analysis of meson reactions at 1.5 BeV, the scattering cross-sections by this interaction are estimated and are compared with those by the usual meson–nucleon interaction. When the $(\lambda/16)(\phi_\alpha \phi_\alpha)^2$ interaction is adopted as a simple model, the effect of this interaction is very small when the value of $(\lambda/4\pi)^2 \cong 1.5$, which has been adopted to explain the $\pi-2\pi$ process at 1.5 BeV. A.

530.145

6901. ON THE CONSERVATION LAWS FOR WEAK INTERACTIONS. L.D.Landau.
Zh. éksper. teor. Fiz., Vol. 32, No. 2, 405-6 (1957). In Russian.
English translation in Nuclear Physics, Vol. 3, No. 1, 127-31 (1957).

It is pointed out that violation of the law of parity conservation need not imply an asymmetry of space with respect to inversion, if one assumes that interactions are invariant under combined inversion (parity and charge conjugation together). It follows from this that despite breakdown of parity conservation particles cannot possess electric dipole moments. J.W.G.Wignall

530.145

6902. ONE POSSIBILITY FOR POLARIZATION PROPERTIES OF THE NEUTRINO. L.D.Landau.
Zh. éksper. teor. Fiz., Vol. 32, No. 2, 407-8 (1957). In Russian.
English translation in second part of Nuclear Physics, Vol. 3, No. 1, 127-31 (1957).

If combined inversion (see preceding abstract) holds then it is possible to specify the neutrino by a two-component wave-function. The neutrino is completely polarized in the direction of its motion, whereas the antineutrino is polarized in the opposite direction. On the basis of this theory the angular distribution of electrons from muon decay is derived, and it is pointed out that beta-decay electrons should have a polarization $\pm (v/c)$ in their direction of motion.

J.W.G.Wignall

530.145

6903. THE HARTREE–FOCK METHOD IN THE CASE OF AN UNORTHOGONALIZED SYSTEM OF SINGLE ELECTRON WAVE-FUNCTIONS. P.Szépfalusy.
Acta phys. Hungar., Vol. 6, No. 2, 273-92 (1956). In German.

The equation satisfied by the "best" system of unorthogonal wave-functions is derived, and also the expression for the energy as a function of these wave-functions. P.M.Davidson

530.145

6904. THE THOMAS–FERMI APPROXIMATION IN QUANTUM MECHANICS. N.H.March.
Advances in Phys., Vol. 6, 1-101 (Jan., 1957).

Review of theory and applications (excluding applications to nuclei). Contents: 1. Introduction. 2. The Thomas–Fermi (TF) equation. 3. Introduction of exchange. 4. Solutions with spherical symmetry. 5. Atoms: binding energies; modification of the TF charge distribution; linear and angular momentum distributions; atoms with non-zero total angular momentum; eigenvalues for statistical potentials; analytical approximations to the TF solution for isolated atoms. 6. Molecules: diatomic molecules (homonuclear and heteronuclear molecules); molecules with high symmetry (formulation of the problem, energetic considerations, introduction of exchange for methane, silane and germane, an improved electron distribution in methane, molecules with heavy atoms in the outer positions); electron distribution in water and phosphine; the benzene molecule; dipole moments of molecules. 7. Solids: perfect crystals (cohesion of the alkali metals, momentum distribution of electrons in metals, effect of binding on X-ray scattering factors, attempt to include angular terms in the TF potential); the perturbed lattice (fields round impurities in monovalent metals, applications to resistivity of dilute alloys, solute diffusion in metals, etc., distribution of electrons round an edge dislocation in a metal, impurities in semiconductors). 8. Material under high pressure: equations of state from the TF and Thomas–Fermi–Dirac models; TF equations of state for the case of incomplete degeneracy; generalized TF theory for arbitrary degeneracy; generalized TF method with exchange; relation of TF equations of state to existing measurements. 9. Extensions of the TF theory and its fundamental basis: the extended TF methods of Weizsäcker and Plaskett; Swiatecki's method; the density matrix; theory of the TF energy formula; relativistic generalization of the TF method. 185 references. E.H.Sondheimer

530.145

6905. A DISCUSSION OF SCHRÖDINGER'S TREMBLING PHENOMENON IN TERMS OF TAKABAYASI'S RELATIVISTIC HYDRODYNAMICS. V.V.Raman.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1155-7 (Feb. 25, 1957).
In French.

Halbwachs, Lochak and Vigier (Abstr. 911/1956) have given a hydrodynamical interpretation of Dirac's equation introducing new (causal) tensor variables. This model is here applied to the interference of a positive energy state with a negative energy one. The new variables have then a frequency double that of the interfering waves and a vibration of amplitude $c\,(E^2-p^2c^2)^{1/2}\hbar/2\,E^2$ results. Only kinematical relations are considered. L.Pincherle

530.145

6906. ON THE THEORY OF NON-STATIONARY PROCESSES IN QUANTUM MECHANICS. P.Roussopoulos.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1732-4 (March 25, 1957).
In French.

The non-stationary solutions of the Schrödinger equation, with interaction, are discussed by means of an integral in the complex plane. Applications are given in a later communication (see abstract following). P.M.Davidson

530.145

6907. ON THE LIFETIME OF EXCITED STATES AND THE WIDTH OF SPECTRAL LINES IN QUANTUM ELECTRODYNAMICS. P.Roussopoulos and G.Vardalakis.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1888-90 (April 1, 1957).
In French.

The method developed in the preceding abstract is applied to these two problems. P.M.Davidson

530.145

6908. SOME WAVE-FUNCTIONS OF A NEW TYPE, SOLUTIONS OF NON-LINEAR EQUATIONS GENERALIZING THE EQUATION OF WAVE MECHANICS. G.Petiau.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1890-3 (April 1, 1957).
In French.

Some non-linear generalizations of the Klein–Gordon wave-equation may be solved by the use of Jacobi's elliptic functions.

P.M.Davidson

530.145 : 530.12

6909. RELATIVISTIC INVARIANCE OF QUANTUM-MECHANICAL EQUATIONS. E.Wigner.
Helv. phys. Acta, Suppl. IV, 210-26 (1956).

"Relativity theory Jubilee" paper (see Abstr. 5818). Single particle equations in Euclidean, Minkowski and de Sitter space-time are related to the irreducible representations of the corresponding symmetry groups. The transition to the space-time of general relativity is discussed in general terms and the suggestion is made that particle equations be expressed in a form in which coordinates do not occur explicitly. R.A.Newing

530.145

6910. RELATIVISTIC COVARIANCE AT THE BASIS OF QUANTUM MECHANICS. O.Costa de Beauregard.
Helv. phys. Acta, Suppl. IV, 72-5 (1956). In French.
"Relativity theory Jubilee" paper (see Abstr. 5818).

530.145

6911. THE POLYNOMIAL REQUIREMENT FOR THE DETERMINATION OF EIGENVALUES. W.Romberg.
K. Norske Vidensk. Selsk. Forhandl., Vol. 28, No. 1, 62-6 (1955). In German.

The customary argument in the case of the harmonic oscillator is considered unsatisfactory and replaced by one involving a condition at $x = +\infty$ and at $x = -\infty$. W.A.Hepner

530.145

6912. CONTINUED FRACTION APPROXIMANTS TO THE BRILLOUIN–WIGNER PERTURBATION SERIES.
R.C.Young, L.C.Biedenharn and E.Feenberg.
Phys. Rev., Vol. 106, No. 6, 1151-5 (June 15, 1957).

The Brillouin–Wigner series for the energy is converted into a continued fraction. Refinements on the Brillouin–Wigner formulae developed in recent publications (Abstr. 1866/1956) are identified with alternate ($E^{(n)}$) approximants to the continued fraction. A second-sequence of approximants [$E^{(n+1/2)}$] occurs between successive terms of the $E^{(n)}$ sequence. These are useful in calculations as shown by an illustrative example, but do not possess the extremum property which is a valued characteristic of the first sequence. A general proof is given that the approximants $E^{(n)}$ are invariant under the $\mu$-transformation defined and verified for n = 1, 2, and $\infty$ in an earlier publication. A.

530.145

6913. EXTENSION OF THE W.K.B. EQUATION.
C.E.Hecht and J.E.Mayer.
Phys. Rev., Vol. 106, No. 6, 1156-60 (June 15, 1957).

The W.K.B. form suitable for the classical region of potential energy less than the total energy, $\psi(x) = (dz/dx)^{-1/2} \sin z$, is used to obtain a function z(x) that reproduces the time-independent Schrödinger equation solutions $\psi(x)$, to any desired degree of accuracy through the turning point and into the nonclassical region. A.

530.145

6914. PARTIAL DESCRIPTION OF QUANTUM-MECHANICAL SYSTEM. G.Araki.
Progr. theor. Phys., Vol. 16, No. 3, 197-211 (Sept., 1956).

A quantum-mechanical system is divided into several partial systems which are interacting each other. The general and practical methods of extracting one of the partial systems are discussed. If a one-dimensional partial system is extracted the two-particle interaction in the partial system is a long-range part of the two-particle interaction in the original system and its short-range part is absorbed in the average field due to the remaining part of the system. It is noted that the light absorption of long carotenoids is due to the plasma oscillation of $\pi$-electrons caused by the long-range part of the Coulomb interaction. The mechanism of screening the short-range part is somewhat different from that of the three-dimensional case. A.

530.145

6915. DESCRIPTION OF STATES IN QUANTUM MECHANICS BY DENSITY MATRIX AND OPERATOR TECHNIQUES. U.Fano.
Rev. mod. Phys., Vol. 29, No. 1, 74-93 (Jan., 1957).

Reviews the methods and potentialities of the treatment of mixed states (states of less than maximum information) by means of density matrices. A variety of examples are given and the point of view is in some respects novel. P.M.Davidson

530.145

6916. METHOD OF FUNCTIONALS IN QUANTUM FIELD THEORY.
Yu.V.Novozhilov and A.V.Tulub.
Uspekhi fiz. Nauk, Vol. 61, No. 1, 53-102 (1957). In Russian.

Survey article with 53 references covering such topics as: the method of Fok (Fock) functionals, the generating functional for amplitude of the new Tamm–Dancoff method, generating functionals for relativistic functions and functional integration, space–time treatment of the topic, variation of the operator and functional integration in the case of a Fermi field. C.R.S.Manders

530.162

6917. STATISTICAL MECHANICAL THEORY OF TRANSPORT PHENOMENA IN A FULLY IONIZED GAS. W.E.Brittin.
Phys. Rev., Vol. 106, No. 5, 843-7 (June 1, 1957).

Nonequilibrium statistical mechanics, as developed by Kirkwood, Irving, and Zwanzig, is applied to a system of charged particles interacting via the electromagnetic field. Particles and field are treated statistically both from the classical and quantal points of view. It is shown that Maxwell's equations are valid for the quantum statistical ensemble-averaged fields. An exact form for the hydromagnetic equations is derived, and it is shown that these equations differ from those which are customarily considered to be exact. A.

530.162

6918. THE STATISTICAL MECHANICS OF THE STEADY STATE.
H.N.V.Temperley.
Proc. Phys. Soc. B, Vol. 70, Pt 6, 577-89 (June, 1957).

It is shown that the Fowler–Darwin definitions of the temperature and chemical potential can be extended in a natural way to cover non-equilibrium but steady assemblies. The concept of equilibrium is replaced by the more general one of "compatibility", and it becomes possible to show that the proposed statistical definitions of quantities like temperature reduce to suitable averages over the assembly of the locally measured quantities. The usual restrictions to small departures from equilibrium are unnecessary. A simple problem (flow of gas in a tube) is discussed from the new point of view. A.

530.162

6919. ON THE GRAND CANONICAL DISTRIBUTION METHOD OF STATISTICAL MECHANICS. Y.Yamamoto and H.Matsuda.
Progr. theor. Phys., Vol. 16, No. 4, 269-86 (Oct., 1956).

Usually the grand canonical distribution method is derived only through plausibility arguments, and up to the present its accurate proof has never been made proceeding directly from the ergodic theorem. In order to give the method a second basis, the case of ordinary classical liquids is reformulated, and it is shown to be practically equivalent to both the microcanonical and the canonical distribution methods. It is concluded that any one of the three methods of statistical mechanics can be safely used, even for the purpose of investigating phase-change. A.

530.162

6920. ON THE BOSE–EINSTEIN CONDENSATION. S.Katsura.
Progr. theor. Phys., Vol. 16, No. 6, 589-603 (Dec., 1956).

The canonical partition function of the ideal Bose–Einstein gas is calculated by the modified method of steepest descent without the continuous spectrum approximation in the cases of periodic boundary condition and of perfectly reflecting wall condition. Above the critical point the steepest curve is the ordinary one through the saddle point. At and below the lambda temperature the steepest curve is such that the singularity of the integrand lies on it as a cusp, and the ordinary saddle point method loses its validity. The evaluation of the residual term in the integration, however, justifies the usual expression of the extensive quantities per particle and intensive quantities as N and V sufficiently large. In deriving the above results, a sufficient condition for the justification of the substitution of $b_1^0$ for $b_1^0(V)$ in canonical partition function of the imperfect gas is given and discussed. A.

530.162 : 518.61

EQUATIONS OF THE DIFFUSION TYPE WITH DIFFUSIVITY CONCENTRATION-DEPENDENT. See Abstr. 6809

## GENERAL MECHANICS. MECHANICS OF SOLIDS 531

531.25 : 535.55

6921. A TILTING STAGE METHOD FOR THREE-DIMENSIONAL PHOTOELASTIC INVESTIGATIONS. H.T.Jessop.
Brit. J. appl. Phys., Vol. 8, No. 1, 30-2 (Jan., 1957).

A method of finding the directions of the principal axes of stress at any point of a "frozen" photoelastic model by the use of a simplified form of universal tilting stage is described. This results in more direct and more accurate measurement of the principal stress-differences at the point. A.

531.391.1

6922. VARIATIONS IN TENSION OF AN UNWINDING THREAD.
K.H.V.Booth.
Brit. J. appl. Phys., Vol. 8, No. 4, 142-5 (April, 1957).

The variations in tension occurring as a thread is pulled with uniform speed from a cylindrical spool are considered. For simplicity the steady state case when the thread follows a curve of constant shape on the surface of the spool is taken. It is shown that there is a limiting value, depending on the tension of winding and speed of the thread, for the angle with which the thread leaves the spool. Curves are given from which it is possible to estimate the variations in tension as the point of unwinding moves up the spool surface. A.

# MECHANICAL MEASUREMENTS 531.7

531.715 : 538.566 : 621.396.962.25

6923. AN INTERFEROMETRIC METHOD OF DISTANCE MEASUREMENT: FREQUENCY MODULATION RADAR. G.Broussaud.
Rev. Opt., Vol. 35, No. 11, 593-603 (Nov., 1956). In French.

The equations governing the measurement of distance by optical interference methods are developed to include distance measurement by f.m. radar. This latter method differs from optical techniques not only in the wavelength employed but in the kind of problem which it solves. D.E.Rae

531.715.2

6924. THE MEASUREMENT OF THE THICKNESS OF THIN CARBON FILMS. A.W.Agar.
Brit. J. appl. Phys., Vol. 8, No. 1, 35-6 (Jan., 1957).

A nearly linear relationship has been found to exist between the optical denstty and the thickness of evaporated carbon films. The determination of film thickness by density measurements is shown to have a number of advantages over measurement by interferometry, particularly for very thin films.

531.754

6925. ACCURATE MEASURING OF THE DENSITY OF SOLIDS, USING HELIUM AS A GASEOUS MEDIUM. H.I.Waterman and P.M.J.Wolfs.
Appl. sci. Res. A, Vol. 6, No. 5-6, 372-84 (1957).

An apparatus is described which can determine the density of solids with an accuracy of at least ±0.02%. The principle of the method is that a constant volume of a gaseous medium is displaced by the sample and the displacement is measured by weighing a corresponding volume of mercury. To keep the volume of the gas sufficiently constant a compensation-manometer is used, which enables the influence of temperature and pressure fluctuations to be counterbalanced. Helium is used because its use involves less complications than the use of other media. A.

531.787.9 : 537.228.1

6926. MEASUREMENT OF THE PRESSURE OF EXPLOSIONS IN GASEOUS MIXTURES WITH THE AID OF A PIEZOELECTRIC DEVICE. I.S.Zheludev and V.M.Makarov.
Kristallografiya, Vol. 1, No. 3, 370-2 (1956). In Russian.

The device itself, the arrangement for recording the pressure, the calibration limits, the sensitivity and testing of the apparatus are described and discussed. R.F.S.Hearmon

# MECHANICS OF FLUIDS 532

532.13 : 536.48

6927. HYDRODYNAMICS OF OSCILLATING DISKS IN VISCOUS FLUIDS: VISCOSITIES OF LIQUIDS $He^3$ AND $He^4$. R.D.Taylor and J.G.Dash.
Phys. Rev., Vol. 106, No. 3, 398-403 (May 1, 1957).

The viscosities of liquid $He^4$ from the lambda-point to 4°K and of liquid $He^3$ near the critical point and from 1.3°K to 2.15°K have been determined by the oscillating disk method. Detailed study of $He^4$ near the lambda point shows a discontinuity in the temperature derivative of the viscosity and provides additional evidence that the He I—He II transition is of the second order. Considerations based upon the temperature dependence of the $He^4$ viscosity above 2.5°K suggest that the zero-point kinetic energy plays an important role in determining the transport properties. The viscosity of liquid $He^3$ rises as the temperature decreases, from a value of 18.7 micropoise at 3.35°K to 26.8 micropoise at 1.3°K. A simple empirical equation describes the $He^3$ data over the entire temperature range. A.

532.13 : 537.226.1

DIELECTRIC RELAXATION, VISCOSITY AND FREEZING.
See Abstr. 6143

532.13.08

6928. EXPERIMENTAL MEASUREMENT OF THE VISCOSITY OF A STRETCHED LIQUID. A.P.Toropov and A.I.Kitova.
Zh. éksper. teor. Fiz., Vol. 32, No. 2, 372-3 (1957). In Russian.

Measurements were carried out by Stokes' method with $C_6H_6$ (pure but not completely degassed). A cylindrical glass ampoule of 6 mm diameter was filled with $C_6H_6$ so as to leave a small air bubble, an Al-coated glass sphere (0.05-0.06 mm dia.) was put into the ampoule, after which $C_6H_6$ was frozen and the ampoule sealed and inserted into a frame fitted with two cross lines 100 mm apart and capable of placing the ampoule rapidly into a strictly vertical position. First the temperature of the complete dissolution of the air bubble and that of the appearance of discontinuity were determined for each of the three ampoules prepared, and then the times of falling (from one cross line to another) were determined for temperatures 0-3°C below the temperature of dissolution. Parallel measurements were made with non-stretched $C_6H_6$. The viscosity values calculated from the times of falling and densities of $C_6H_6$ showed that: (1) the viscosity of the stretched $C_6H_6$ can be measured with an accuracy of ±0.03 millipoise and (2) contrary to Worthington's opinion (1893), this method is quite suitable for measuring the viscosity of stretched liquids. F.Lachman

532.517

6929. AN APPLICATION OF THE DIFFUSION EQUATION TO VISCOUS MOTION WITH A FREE SURFACE. J.R.Philip.
Austral. J. Phys., Vol. 9, No. 4, 570-3 (Dec., 1956).

It is shown that the steady one-dimensional flow of a liquid over any plane surface in a gravitational field can be solved as a problem in diffusion. In the problem of surface irrigation it has previously been difficult to include the effect due to surface vegetation. In the present work it is suggested that the introduction of a height-variable permeability solves this problem. T.C.Toye

532.525

6930. CONTROL OF THE DISTRIBUTION OF A SPRAY PROJECTED TO AN AREA. D.J.Rasbash and G.W.V.Stark.
J. sci. Instrum., Vol. 34, No. 2, 75-6 (Feb., 1957).

Deals with the production of water sprays by nozzles for the purpose of fire extinction. The nozzles consist of a number of radially arranged pairs of jets, the two types considered being arranged to give two different spray angles. In each case it was found that the inclusion of an orifice plate immediately upstream of the jets produced a marked improvement in the spray distribution. A possible explanation is advanced and it is suggested that the use of different size orifices would be a method of spray control. T.C.Toye

# MOLECULAR THEORY OF LIQUIDS 532.7

532.7

6931. ON THE LACUNA STRUCTURE OF LIQUID FLUORIDES. J.Zarzycki.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 758-60 (Feb. 4, 1957). In French.

A study of liquid fluorides (NaF, LiF and KF) by X-ray diffraction yields radial distribution functions which show that the coordination number in the liquid is very much less than in the solid. At the same time however, the short-range order seems to be the same for both solid and liquid. It is thought that a lacuna (a biological cell type) structure would fit the facts. T.C.Toye

532.7

6932. DIRECT CORRELATION FUNCTIONS FOR ARGON. A.Reetz, Jr and L.H.Lund.
J. chem. Phys., Vol. 26, No. 3, 518-21 (March, 1957).

Direct correlation functions as defined in the Ornstein—Zernike liquid model have been calculated from the argon X-ray scattering data corresponding to several points on the liquid—vapour transition curve. Graphs of these direct correlation functions are presented along with an integral check on their general validity. It is concluded these correlation functions derived from the X-ray scattering data are a reasonable representation of these functions. A.

532.7 : 536.71

6933. EQUATION OF STATE FOR WATER AT EXTREME PRESSURES. J.H.Rosenbaum.
J. chem. Phys., Vol. 26, No. 3, 684-9 (March, 1957).

A new equation of state for water is derived from theoretical considerations. This is used to obtain a smoothed extrapolation of Bridgman's P-V data to extremely high pressures. A.

532.71

6934. NON-ISOTHERMAL MEMBRANE POTENTIALS. G.J.Hills, P.W.M.Jacobs and N.Lakshiminarayanaiah.
Nature (London), Vol. 179, 96-7 (Jan. 12, 1957).

An equation is given for $J_i$, the flux of the i-th component through the membrane of a membrane-cell in which the two halves are at different temperatures. A partial attempt to test the predictions of the equation is referred to. W.Good

532.72 : 536.2.02

6935. ANALOGIES OF THERMAL DIFFUSION IN LIQUIDS: IMPULSE METHOD. E.Calvet and H.Patin.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1492-4 (March 11, 1957). In French.

Some years ago an interference method was described for the investigation of vertical diffusion in liquids (Calvet; C.R. Acad. Sci. (Paris), Vol. 220, 596; Vol. 221, 403, 1945). The necessary equations are the same for heat transfer and these are applied to a thermal impulse or shock. E.H.Dock

532.74

6936. ON THE ASSOCIATION OF POLAR MOLECULES STUDIED BY DISPERSION AND ABSORPTION OF THEIR SOLUTIONS IN THE DECIMETRE WAVELENGTH REGION. E.Fischer and N.Zengin.
Z. Phys., Vol. 147, No. 1, 113-24 (1957). In German.

The dielectric constants ($\epsilon'$) and loss factors ($\epsilon''$) are reported at wavelengths from 67 to 14 cm for solutions of o-cresol, eugenol and n-methylacetamide in $CCl_4$ and $C_6H_6$. Both o-cresol and eugenol show the expected departures from the Debye curves and the results confirm previous loss measurements made at longer wavelength, along with a correlation between the average relaxation time and molecular association. N-methylacetamide is strongly associated even at low concentrations (1 – 5 mol.%). Mixtures of dilute solutions of phenol and n-methylacetamide in benzene up to a total solute concentration of 2.5% have also been studied. The measured $\epsilon''$ values of the mixture differ from the sum of the $\epsilon''$ values for the components, especially for 1 : 1 mixtures or mixtures containing excess phenol. A small amount of phenol in n-methylacetamide solutions does not change $\epsilon''$ so markedly presumably because of the strong self-association of the latter. G.Allen

532.77

6937. THERMODYNAMICAL STUDY OF A SOLUTION OF LEAD NITRATE IN LIQUID POTASSIUM NITRATE.
Y.Doucet and C.Janot.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1166-9 (Feb. 25, 1957). In French.

The results of cryoscopic measurements are discussed. It is shown that they indicate a negative deviation from Raoult's law i.e. the activity coefficient of the solvent $<< 1$. The deviation can be attributed to the difference in space occupied by the ions $K^+$ (10 $A^3$) and $Pb^{++}$ (2.5 $A^3$). S.Weintroub

# MECHANICS OF GASES 533

533.5

6938. HIGH VACUUM GASKETS CAPABLE OF BEING DEGASSED. M.J.Higatsberger.
Acta phys. Austriaca, Vol. 10, No. 3, 181-5 (1956). In German.

Metal gaskets of Al, Ag, Cu, Pb, Au and Sn compressed against tube rims can be baked at 400° C and withstand high vacuum. Glass windows can be mounted by depositing a copper film up to 0.5 mm thick onto the chromium plated rim of the window. The copper is also chromium plated and the window pressed against an Al rim gasket to withstand baking and high vacuum. D.Haneman

533.5

6939. THE CONDUCTANCE OF A COLUMN OF VAPOUR FOR GASES AT LOW PRESSURES. D.S.Stark.
Brit. J. appl. Phys., Vol. 8, No. 5, 210-13 (May, 1957).

Vacuum systems often contain stationary columns of vapour. A general expression is derived for the conductance of such a column for gases at low pressures. A rough experiment using columns of mercury vapour yielded values for the conductance for air and hydrogen which were of the same order of magnitude as the values predicted from the expression given. It is shown that the conductance of the vapour can be less than that of the pipe which contains it. This becomes increasingly probable as the pipe diameter and the vapour pressure are increased. A.

533.583 : 621.385.032.94

6940. BARIUM GETTERS AND OXYGEN. R.N.Bloomer.
Brit. J. appl. Phys., Vol. 8, No. 1, 40-3 (Jan., 1957).

The sorption of oxygen by films of barium evaporated in a vacuum has been studied. The speed of pumping and the capacity were measured. The speed of pumping has been found to be almost independent of the ionizing electron current in the oxygen gas. However, towards the end of the life of a film, it was found that all pumping ceased unless a hot tungsten filament was alight in the gas. Measurements of the variation of speed in the early life of a getter film, and of the influence of evaporation conditions upon pumping, show the importance of nucleation centres at which oxidation starts. The increase of speed and capacity with temperature show that these are limited by diffusion processes within the getter film. A.

533.59

6941. VACUUM DEPOSITION APPARATUS. F.W.Cuckow.
J. sci. Instrum., Vol. 34, No. 1, 36 (Jan., 1957).

To view the vapour source and other contents of a vacuum chamber the author has used two slips of glass exposed to the vapour beam, one to keep the observation window free from metal by obstruction of the beam and the other as a mirror in which the source and contents may be seen by looking through the window. S.Weintroub

533.6.01

6942. A STUDY OF AIRCRAFT RESPONSE TO SUDDEN AND GRADED WIND GUSTS BY MEANS OF A DIFFERENTIAL ANALYSER. W.R.Blunden, F.H.Hooke and H.K.Messerle.
Brit. J. appl. Phys., Vol. 8, No. 4, 167-73 (April, 1957).

The solution of the "gust" problem for a range of parameters, sufficient to give results that would be useful to designers, is not practicable without the aid of an automatic computer. This paper describes the assumptions made for a detailed analysis on a mechanical differential analyser and the results obtained are summarized. Some discussion is given on the speed and accuracy of the solutions obtained. A.

533.6.011

6943. THE FLOW OF GAS THROUGH COMPOSITE SYSTEMS AT VERY LOW PRESSURES. C.W.Oatley.
Brit. J. appl. Phys., Vol. 8, No. 1, 15-19 (Jan., 1957).

It is shown that the conventional method of calculating the flow of gas at very low pressure through composite systems is based on an untenable assumption and leads to incorrect results. An improved method of calculation is given which, though not exact, is unlikely to lead to errors exceeding a few per cent. The physical basis of this method is discussed and its application to various problems of practical importance is considered. A.

533.6.011 : 536.244

HYDRAULIC RESISTANCE FOR A HIGH-VELOCITY GAS FLOW.
See Abstr. 6101

# MOLECULAR THEORY OF GASES 533.7

533.7

6944. ON THE SOLUTION OF THE BOLTZMANN EQUATION FOR AN IMPERFECT LORENTZIAN GAS. APPLICATION TO WEAKLY IONIZED GASES.
M.Bayet, J.L.Delcroix and J.F.Denisse.
C.R. Acad. Sci. (Paris), Vol. 244, No. 2, 171-3 (Jan. 7, 1957). In French.

See Abstr. 8978 (1954). The authors' method of expansion in series of eigenfunctions of the collision operator is used to study the time dependence of isotropic distribution functions for a Lorentzian gas with non-zero mass ratio. The effect of an applied electric field is also studied. E.H.Sondheimer

533.7

6945. THE BASIS OF KINETIC THEORY. EVOLUTION AND IRREVERSIBILITY OF SYSTEMS. S.Marquet.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1463-6 (March 11, 1957). In French.

A system of n bodies is studied. It is described by a measure on the space of velocities. The fundamental equation was solved in a previous note (Abstr. 4034/1957). The solutions are now studied from the point of view of their behaviour with time, and their asymptotic forms are derived. L.S.Goddard

533.7: 536.423.4

6946. ON THE THEORY OF CONDENSATION. K.Ikeda.
Progr. theor. Phys., Vol. 16, No. 4, 341-88 (Oct., 1956).

The Mayer–Born–Kahn–Uhlenbeck theory of imperfect gases and condensation phenomena has treated the ideal systems, for which the volume dependence of the cluster integrals is completely neglected, but the present paper treats the real systems, for which the volume dependence of the cluster integrals is rigorously taken into consideration. A sequence of lemmas and theorems is proved, which may be useful for the treatment of the real systems, and which may therefore contribute to the theory of imperfect gases and condensation phenomena. Then, from the analytical viewpoint, the condensation phenomena of the real systems, and the correct-

ness of Mayer's theory about the connection between the phase transitions and the singularities are discussed. A.
533.7

6947. THE SECOND VIRIAL COEFFICIENTS OF A, Kr, Xe, $N_2$, AND $CO_2$ IN THE TEMPERATURE RANGE 0° TO 1200°C.
W.Thomas.
Z. Phys., Vol. 147, No. 1, 92-8 (1957). In German.

For the calculation the (6-12) power intermolecular potential of Lennard-Jones was used, whose parameter was adjusted to fit the more recently experimentally determined virial coefficients of the above gases, which were measured up to 700°C. F.Ansbacher
533.72

6948. ON THE RANDOM MOTION OF THE MOLECULES IN A GAS. I. C.Christov.
Acta phys. Hungar., Vol. 6, No. 2, 325-36 (1956). In German.

Let $W(t,\vec{r},\vec{u},\vec{v})d\vec{r}d\vec{v}$ be the probability that a molecule which at time $t_o$ has velocity $\vec{u}$ has at time $t_o+t$ a velocity between $\vec{v}$ and $\vec{v}+d\vec{v}$, with a displacement between $\vec{r}$ and $\vec{r}+d\vec{r}$. The author discusses the calculation of W for the model of rigid elastic spheres, and sets up an integral equation for W which is solved by iteration. The author also gives two differential equations for W. E.H.Sondheimer
533.75 : 536.71

6949. A FORM FOR THE EQUATION OF STATE. J.Duclaux.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1427-9 (March 11, 1957). In French.

The form $P(V-b)[1+A(V-b)^{-n}] = RT$ is suggested, where b is the usual covolume, independent of P and T, and A and n (~1) are functions only of T, A decreasing with increase of T. It is accurate over large ranges of P and T, particularly for high P, failing only near the critical point. It has some theoretical justification, and expresses also the empirical law of "isocondensation" (Abstr. 8564/1950, 2456/1951, 5938/1955). J.Hawgood
533.75 : 536.71

6950. WOULD A CLASSICAL GAS OF NON-ATTRACTING RIGID SPHERES SHOW A PHASE TRANSITION? H.N.V.Temperley.
Proc. Phys. Soc. B, Vol. 70, Pt 5, 536-7 (May, 1957).

It is well known that the Kirkwood–Monroe theory (1941) predicts a gas–liquid phase transition for a model of rigid spheres. This theory is however "practically equivalent" to the "netted ring" approximation of Rushbrooke and Scoins which is here compared with exact calculations on a model due to Zwanzig (Abstr. 3554/1956). "Netted ring" virial coefficients are shown to "go wrong" by the fifth and it is therefore concluded that there is no evidence for the reality of the Kirkwood–Monroe transition. R.O.Davies

## VIBRATIONS. ACOUSTICS 534

534.1

6951. FORCED OSCILLATIONS OF A SIMPLE NON-LINEAR SYSTEM. I. THE DIFFERENTIAL EQUATIONS AND THEIR STATIONARY SOLUTIONS. W.Braunbek.
Z. Phys., Vol. 147, No. 3, 297-306 (1957). In German.

The differential equation for the modulation function is solved in two ways. The forcing term is taken in the form $ax + bx^3$. The stationary oscillations with and without damping are discussed, and resonance curves are drawn. The critical damping is determined. Below this unstable stationary oscillations are possible.
L.S.Goddard
534.1

6952. FORCED OSCILLATIONS OF A SIMPLE NON-LINEAR SYSTEM. II. NON-STATIONARY MOTIONS.
W.Braunbek and E.Sauter.
Z. Phys., Vol. 147, No. 5, 507-15 (1957). In German.

A continuation of the preceding abstract. The equations for the slowly varying amplitude and phase are solved. Elliptic functions are involved. Families of possible motions are investigated, without damping, and finally the case with damping is treated.
L.S.Goddard
534.112 : 531.391.1

6953. TRANSVERSE VIBRATIONS OF POWER TRANSMISSION CHAINS. S.Mahalingam.
Brit. J. appl. Phys., Vol. 8, No. 4, 145-8 (April, 1957).

In this paper the natural frequencies of a travelling chain are determined by treating the chain as a uniform string. For a constant chain tension the natural frequencies decrease progressively to zero as the chain speed approaches the velocity of transverse wave propagation. In practice such a condition is not obtained since the chain tension increases with speed owing to centrifugal effects. Formulae are obtained for the amplitude of forced vibration of the chain when excited by a transverse displacement at one end. The effect of damping is considered and exact and approximate methods of determining resonant amplitudes are given. A.
534.131

6954. THE FUNDAMENTAL MODES OF VIBRATION OF UNIFORM BEAMS FOR MEDIUM WAVELENGTHS. G.J.Kynch.
Brit. J. appl. Phys., Vol. 8, No. 2, 64-73 (Feb., 1957).

The Rayleigh–Ritz method is used to determine approximate forms for the dispersion curves of a vibrating infinite beam of arbitrary shape, using the exact elasticity equations. The method is also used to investigate the relations between the different types of vibration. The results for flexural vibrations confirm the Timoshenko equation for most beams and include corrections for thin strips. Dispersion curves are obtained for longitudinal-type vibration which shows the variation with shape and the change in classification of the modes when the symmetry of the cross-section is altered. When the wavelength is of the order of magnitude of the perimeter, the usual longitudinal mode is replaced as the fundamental mode by a new mode. A.
534.2

6955. SOME LAWS OF PROPAGATION OF WAVES IN AN HOMOGENEOUS MEDIUM. A.S.Alekseev.
Dokl. Akad. Nauk SSSR, Vol. 103, No. 6, 989-92 (1955). In Russian. English translation in: Atomic Energy Res. Establ. (Harwell) Transl. No. 750 (1956).

The equations of motion for an inhomogeneous elastic medium are solved, after making certain assumptions about the character of the inhomogeneity of the medium and the boundary conditions. The mathematical procedure is outlined, reference being made to other Russian work for the details. The physical interpretation of certain solutions is briefly discussed. H.J.H.Starks
534.2

6956. A PARTICULAR CASE OF THE PROPAGATION OF ELASTIC WAVES IN CRYSTALS. K.S.Aleksandrov.
Kristallografiya, Vol. 1, No. 1, 138-9 (1956). In Russian.

The cases considered relate to the propagation of transverse waves (1.67 Mc/s) in ammonium dihydrogen phosphate along a two-fold axis. Phenomena analogous to optical polarization and double refraction are discussed and illustrated by experimental oscillograms. See also Abstr. 687, 691 (1953); 2525 (1955).
R.F.S.Hearmon
534.2 : 539.371

6957. ROTATION OF THE PLANE OF POLARIZATION OF SHEAR ELASTIC WAVES.
K.S.Aleksandrov and V.Ya.Khaĭmov-Mal'kov.
Kristallografiya, Vol. 1, No. 3, 373-4 (1956). In Russian.

A crystal of sodium chloride with its length in the [110] direction was heated and one end twisted through 90° relative to the other. Ultrasonic shear impulses, frequency 1.67 Mc/s were propogated through the crystal and through a control specimen. The plane of polarization was found to be rotated through 90° in the twisted specimen. R.F.S.Hearmon
534.22

6958. VELOCITY OF ULTRASONIC WAVES IN ETHYLENE AT PRESSURES UP TO 1000 ATM. Abdel Aziz M'Hirsi and J.Noury.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1169-71 (Feb. 25, 1957). In French.

This has been measured in 99.95% pure ethylene at temperatures 25° and 50°C and at frequencies 0.87, 2.6 and 4.3 Mc/s. There is no evidence of dispersion and the derived specific heat ratios compare well with the theoretical values. H.D.Parbrook
534.2

6959. A METHOD FOR COMPARING ULTRASONIC VELOCITIES IN SOLIDS AND LIQUIDS USING A SPECTROMETER.
E.Hayess; G.M.Sreekantath and A.O.Mathai.
J. sci. Instrum., Vol. 34, No. 3, 125, 126 (March, 1957).

A criticism of a paper by Sreekantath and Mathai (J. sci. Instrum., Vol. 33, No. 9, 361, Sept., 1956), and their reply.
T.C.Toy
534.222

6960. PROPAGATION OF SOUND IN A VARIABLE WIND.
Y.Rocard.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1339-41 (March 4, 1957). In French.

This is shown theoretically to consist of ordinary sound waves of amplitude depending upon the wind velocity gradient in the direct

on of propagation. A method for turbulence measurement is suggested. H.D.Parbrook

534.222.2

6961. BIBLIOGRAPHY ON SHOCK WAVES, SHOCK TUBES, AND ALLIED TOPICS. K.Dolder and R.Hide.
Atomic Energy Res. Establ. (Harwell), Rep. G/R2055, 94 pp. (1957).

References have been arranged under subject headings in chronological order. The sections dealing with shock waves and shock tubes include most of the work published in these fields up to the end of 1955. A number of more recent references are also included. Further sections list accounts of related subjects. The bibliographies previously compiled by the National Physical Laboratory and Princeton University are also included. A.

534.232 : 621.373.421.13 : 621.372.412

6962. QUARTZ CRYSTALS AS OSCILLATORS AND RESONATORS. D.Fairweather and R.C.Richards.
Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex, 54 pp. (1956).

This monograph has been compiled to provide information in a practical form for potential users of quartz crystals. The subjects covered include: vibration theory of crystals; crystal cuts; temperature coefficient; mounting methods; frequency tolerances; design of quartz oscillators. R.F.S.Hearmon

534.232 : 621.395.623.75

6963. ANALYSIS OF THE WAVE-PARAMETERS OF THE EXPONENTIAL HORN. J.Kacprowski.
Arch. elektrotech. (Warsaw), Vol. 5, No. 4, 719-58 (1956). In Polish, with summary (600 words) in English.

A mathematical paper in which the exponential horn is considered as an acoustic four-terminal network. The equations for the network are set in matrix form and shown to correspond to a cascade connection of three four-terminal networks: an ideal, frequency-independent transformer, a transformer with transformation ratio dependent on frequency, an acoustic filter with alternating transmission and attenuation bands. Wave-parameters are derived from the equations in a formal manner and their physical interpretation is discussed. The concept of the wave impedance of the horn is analysed in detail, and the author shows that the horn cannot be considered as an iterative chain of matched elementary networks, but it may be considered as a lossless transmission line with distributed constants which are functions of the distance. The formal analogy with a transmission line is proved. The conditions under which the horn can be used as an ideal matching transformer are analysed. J.M.Silberstein

534.614

6964. MEASUREMENTS ON THE VELOCITY OF SOUND IN NITROGEN UNDER HIGH PRESSURE.
A.van Itterbeek, W.de Rop and G.Forrez.
Appl. sci. Res. A, Vol. 6, No. 5-6, 421-32 (1957).

Using an acoustical interferometer for high pressures the velocity of sound was measured in nitrogen gas between 1 and 75 atm as a function of pressure and at different temperatures. The experimental data are compared with the direct measurements on the equation of state of nitrogen gas. From the experimental results on the velocity the change of the ratio of the specific heats and the specific heats themselves were calculated as a function of pressure, and at different temperatures. A.

534.614

6965. DISPERSION OF LONGITUDINAL WAVES PROPAGATED ALONG THE TERNARY AXIS IN ALUMINIUM. H.Robert.
Bull. Soc. Franc. Minéral. Crist., Vol. 78, No. 11-12, 535-41 (Oct.-Dec., 1955). In French.

The velocities and frequencies of longitudinal waves are determined in terms of wave vector from the diffusion of X-rays by thermal agitation (see also Abstr. 2755/1948). R.F.S.Hearmon

534.7

PHYSIOLOGICAL ACOUSTICS. HEARING. See also under "Medical science. Human physiology". Decimal classification 612.85

534.839

6966. MEASUREMENTS OF NOISE AND THE EVALUATION OF THE DISTURBING EFFECT.
Poste e Telecom., Vol. 24, No. 11, 1055-60 (Nov., 1956). In Italian.

It is shown that the simplest method of measurement is that of finding the objective sound intensity using a microphone, an attenuator calibrated in dB, and a meter, and either narrow-band filters or wide-band (from ⅓ to 1 octave) filters to analyse the noise spectrum. Without the analyser, the results for very complex spectra, may be several dB in error. The selectivities of narrow, wide, and frequency sensitive, band filters are compared. The disturbing effect is briefly considered with regard to loss of clearness and andibility of conversations. A graph is given of differences in acoustic pressure level with distance from a non-directive noise source, for different values of absorbing power in the surrounding media; its use is explained and it shows that reflected noise (from walls etc.) becomes more important as one moves away from the source. J.J.Phipps

534.843

6967. INVESTIGATIONS ON THE FORM OF THE PULSE USED IN IMPULSE MEASUREMENTS IN ROOM ACOUSTICS. H.Niese.
Hochfrequenztech. u. ElektAkust., Vol. 65, No. 3, 98-108 (Nov., 1956). In German.

The author emphasizes the importance attached to the choice of the characteristics of the sound wave used in investigations of auditorium acoustics. Consideration is given to: (1) the duration of the time function of the sound pulse, (2) the influence of the sound-spectrum of the pulse and the determination of the most desirable type of spectrum, and (3) the required directional characteristics of the sound-wave emitter used in the measurements. Records are shown of the sound pressure-time function of the sound impulse, and of the directional characteristics of the sound transmitter at 420, 3400 and 9200 c/s. The energy-spectrum of the loudspeaker shows a steady increase from zero at 70 c/s reaching a maximum at 850 c/s and falling to zero again at 8 kc/s. A.B.Wood

534.843

6968. THE DEVELOPMENT OF AN "ECHOGRAD" MEASURING APPARATUS. H.Niese.
Nachrichtentechnik, Vol. 6, No. 12, 545-52 (Dec., 1956). In German.

The estimation of the acoustic qualities of rooms depends mostly on the frequency-dependent reverberation time. The latter quantity can however, only characterize the room as a whole. The author now describes a method of investigation of intelligibility or "clearness" at particular places inside a room, so that "syllable-clearness" tests can be carried out. The measurement of this quantity is normally very time-consuming and requires a representative number of observers. By means of the "Echograd" measuring equipment now described the required observation time is much reduced. Use is made of a sound pulse of short duration (see preceding abstract), so that individual "syllable" echoes are resolved with a minimum of overlapping. Such records clearly distinguish between the "wanted" signal and the "disturbing noise". A.B.Wood

## OPTICS. RADIATION. SPECTRA 535

535

6969. SUMMARIZED PROCEEDINGS OF A CONFERENCE ON CONTEMPORARY OPTICS, SYDNEY, 1956.
C.F.Bruce, R.G.Giovanelli and W.H.Steel.
J. sci. Instrum., Vol. 34, No. 4, 129-35 (April, 1957).

A conference held by the Australian Branch of The Institute of Physics in Sydney, September, 1956. In Australia there have been developments in interferometry and in geometrical, physical and instrumental optics. The papers presented are summarized. A.

535.14

6970. THE QUESTION OF CORRELATION BETWEEN PHOTONS IN COHERENT BEAMS OF LIGHT. P.Fellgett.
Nature (London), Vol. 179, 956-7 (May 11, 1957).

It is pointed out that some of the formulae which have been used in discussing this subject rest on dubious assumptions, and that an adequate quantum-mechanical treatment would be desirable. P.M.Davidson

535.14

6971. THE QUESTION OF CORRELATION BETWEEN PHOTONS IN COHERENT BEAMS OF LIGHT. R.Q.Twiss and R.H.Brown.
Nature (London), Vol. 179, 1128-9 (June 1, 1957).

Discusses some criticisms made by Fellgett (preceding abstract) of formulae employed by the authors. P.M.Davidson

535.214.6

6972. THE NATURE OF PHOTOPHORETIC FORCES.
E.Desoyer.
Acta phys. Austriaca, Vol. 10, No. 3, 221-6 (1956). In German.

Direct arguments are used to show that the forces are "radiometric" in character (see following two abstracts). Consideration is given to the interaction of the particles themselves and to local streaming in the suspension gas. W.Good

535.214.6

6973. THE THEORY OF GRAVITO-PHOTOPHORESIS. H.Rohatschek.
Acta. phys. Austriaca, Vol. 10, No. 3, 227-38 (1956). In German.

A theoretical treatment of the screw movement of illuminated particles and the dependence of the movement on the intensity of the light beam. W.Good

535.214.6

6974. THE FORCES IN PURE PHOTOPHORESIS AND IN GRAVITO-PHOTOPHORESIS. H.Rohatschek.
Acta phys. Austriaca, Vol. 10, No. 3, 267-86 (1956). In German.

The investigation is described of the photophoresis of coarser powders ($10^{-4}$ to $10^{-2}$ cm) suspended under reduced pressure in a round glass flask and illuminated by co-axial and oppositely directed beams of light. Various types of movement are illustrated by photographs. It is concluded that the photophoretic forces are akin to those acting in a radiometer. W.Good

535.247.4

6975. A PHOTOGRAPHIC RECORDING MICROPHOTOMETER. J.Bor.
J. sci. Instrum., Vol. 34, No. 4, 140-1 (April, 1957).

A simple method of converting a non-recording microphotometer into a single-beam recording instrument of good discrimination and high speed is described. The existing photovoltaic cell is replaced by a cadmium selenide photoconductive cell. This increases the sensitivity to such an extent that the long period galvanometer is replaced by a much less sensitive, more robust, and very short period galvanometer. By connecting a large ratio reduction gear between the plate slide of the microphotometer and a large photographic drum the instrument is converted to a recording microphotometer of good discrimination, large magnification and high speed, capable of handling a wide range of photographic densities. A.

535.321 : 578.984

REFRACTOMETRY AND INTERFEROMETRY OF LIVING CELLS. See Abstr. 6782

535.323

6976. INFRARED REFRACTIVE INDEXES OF SILICON GERMANIUM AND MODIFIED SELENIUM GLASS. C.D.Salzberg and J.J.Villa.
J. Opt. Soc. Amer., Vol. 47, No. 3, 244-6 (March, 1957).

Infrared index of refraction data are presented for single-crystal germanium and single-crystal silicon. Also included are data for a modified selenium glass. A.

535.323 : 536.421.1

6977. CONNECTION BETWEEN MELTING POINT TEMPERATURES AND REFRACTIVE INDICES OF IONIC CRYSTALS. S.S.Batsanov.
Kristallografiya, Vol. 1, No. 1, 140-3 (1956). In Russian.

An empirical relation of the type $n = a - bt$ is established between refractive index (n) and melting point (t) in alkali halides XY, where X may be Na, K, Rb or Cs, and Y may be F, Cl, Br or I. The constants a and b are characteristic of the cation. R.F.S.Hearmon

535.325 : 539.133

6978. INFRARED DISPERSION OF HYDROGEN BROMIDE. B.Schurin and R.Rollefson.
J. chem. Phys., Vol. 26, No. 5, 1089-91 (May, 1957).

The index of refraction of hydrogen bromide has been measured between 1 and 10 microns. The data has been interpreted to provide values of the electric moment ($\mu$) and the variation of the electric moment with internuclear distance ($d\mu/dr$). The reported values are $\mu = (0.82 \pm 0.04) \times 10^{-18}$ e.s.u and $d\mu/dr = (0.48 \pm 0.04) \times 10^{-10}$ e.s.u. A.

535.33.03

6979. ON THE INTENSITY VARIATIONS IN TIME-RESOLVED SPECTRA OF FLASH LAMPS. M.Cloupeau.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 744-7 (Feb. 4, 1957). In French.

A brief note describing an optical system for obtaining time-resolved spectra of transient gaseous discharges (sparks etc.). Representative spectra, taken with a xenon discharge, are shown and briefly discussed. J.D.Craggs

535.33.03

6980. SUPPRESSION OF CYANOGEN BANDS IN THE CARBON ARC SPECTRUM. A.I.Akimov.
Optika i Spektrosk., Vol. 1, No. 3, 434-6 (1956). In Russian.

In spectroanalytical work the use of carbon electrodes in an atmosphere of air gives rise to a strongly masking action by cyanogen bands. The author overcomes this difficulty by having a tube round the lower carbon electrode through which some neutral gas passes upwards. The latter forms a sheath round the arc isolating it from the air. Illustrations of equipment, also spectrograms with and without neutral $CO_2$ "sheath". C.R.S.Manders

535.33.07

6981. ON THE ROLE OF THE RECEIVER IN THE DETERMINATION OF THE PARAMETERS OF A GRATING SPECTROMETER: APPLICATION TO THE FAR INFRARED ($20\,\mu < \lambda < 1000\,\mu$). A.Hadni.
Ann. Phys. (Paris), Ser. 13, Vol. 1, 765-78 (Sept.-Oct., 1956). In French.

The limiting sensitivity of the receiver determines the resolution; it is shown how the use of a given receiver then determines the dimensions of the rest of a spectrometer. Expressions given by various authors for the "factor of merit" of a receiver are discussed. There may be possibilities of improving resolution by (1) better use of energy from the source: Golay multi-slit etc.; (2) improved performance of receiver, e.g. by working at lower temperature; (3) use of more intense sources. G.F.Lothian

535.33.07

6982. THE ILLUMINATION OF A SPECTROGRAPH BY A THREE-DIMENSIONAL SOURCE OF LIGHT. S.G.Rautian.
Optika i Spektrosk., Vol. 1, No. 3, 439-40 (1956). In Russian.

A tube with the internal wall of reflecting/scattering material may be interposed between the source of radiation and the instrument to serve as a three-dimensional source of light. The optimal dimensions of such a tube are given. The paper is a review of recent work on this topic, the chief of which is that of Brandmüller, (Abstr. 9543/1955). C.R.S.Manders

535.331

6983. THE DETERMINATION OF THE OSCILLATOR STRENGTH OF THE IRON LINE 3720 A FROM THE DECAY TIME OF THE RESONANCE RADIATION. K.Ziock.
Z. Phys., Vol. 147, No. 1, 99-112 (1957). In German.

The oscillator strength of the 3720 A iron line has been determined, using a modulated Kerr-cell technique, from measurements on the decay time of the resonance radiation. The oscillator strength was found to be $0.046 \pm 30\%$. R.W.Nicholls

535.332/.333

6984. THE FAR ULTRAVIOLET EMISSION SPECTRA OF SLIDING SPARKS IN VACUUM, ON ORGANIC SUPPORTS. J.Romand and G.Balloffet.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 739-42 (Feb. 4, 1957). In French.

The spectra of sliding sparks generated in vacuum on supports made from organic high polymers are reported. The emission is rich in carbon lines and relatively poor in lines due to the electrode materials. G.Allen

535.332

6985. SPECTROSCOPIC STUDY OF CAPILLARY SPARKS IN COMPRESSED GASES. Y.Leycuras and R.Aumont.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1910-12 (April 1, 1957). In French.

Spectra of condensed capillary sparks run in hydrogen, helium, and nitrogen appear to be determined mainly by the conditions of the discharge and the material of the capillary. The spectra are independent of pressure. R.W.Nicholls

535.333 : 535.37

6986. RESEARCHES ON THE TRANSITION COMPLEX IN ATOMIC COLLISION PROCESSES. R.Aynard.
Ann. Phys. (Paris), Ser. 13, Vol. 2, No. 1-2, 67-115 (Jan.-Feb., 1957). In French.

Thesis, giving detailed account and interpretation of experiments reported in part in Abstr. 846, 2319/1950, and historical background with 127 refs. The emission spectra due to collisions in diatomic and triatomic systems, in particular (2H,Na) and (Na,Xe) were observed stroboscopically to examine phosphorescence and approximate lifetimes. Atomic H, of lifetime ~0.1 sec, excited the D and 3302 doublets of Na; at the same time, electron collisions activated the nD–3P series of Na, the latter effect also being observed when H was replaced by rare gases. Band spectra of the complex (Na,Xe) were observed, and effective atomic radii of Na and Xe atoms deduced. Study of (HD,Na) and (2D,Na) elucidated the rotational and vibrational contributions to the energy balance in the (2H,Na) system. J.Hawgood

535.334

6987. SOME INFRARED BANDS OF VANADIUM OXIDE. A.Lagerqvist and L.E.Selin.
Ark. Fys., Vol. 11, Paper 40, 429-30 (1957).

Measurements of red-degraded bands from the vanadium arc in the region 10462 to 10565 A are given. The lower state is perhaps the ground state of VO. The bands are also observed in stellar absorption spectra. R.F.Barrow

535.338.332 : 539.153

6988. HYPERFINE SPLITTING IN THE $p^5\ ^2P_{1/2}$ METASTABLE STATE OF $I^{127}$. R.Onaka.
Phys. Rev., Vol. 106, No. 6, 1178 (June 15, 1957).

The hyperfine structure of the $p^5\ ^2P_{1/2}$ metastable state of $I^{127}$ was investigated by means of a vacuum echelle spectrograph. The doublet separation in the $^2P_{1/2}$ state was obtained as 0.667 $cm^{-1}$ and 0.673 $cm^{-1}$ from λ2062 and λ1876, respectively, the mean value being 0.670 $cm^{-1}$. A.

535.338.333

6989. ISOTOPE SHIFT IN THE INFRARED SPECTRUM OF BORIC ACID AND ITS STRUCTURE.
T.A.Sidorov and N.N.Sobolev.
Optika i Spektrosk., Vol. 1, No. 3, 393-402 (1956). In Russian.

The infrared spectra of boric acid with natural mixture of isotopes, and of boric acid where the boron is enriched with $B^{10}$ have been examined over the wave-number range 4000-450 $cm^{-1}$. Infrared shifts were observed as follows: 1448 $cm^{-1}$ shifted by 64 $cm^{-1}$, 1198 $cm^{-1}$ shifted by 9 $cm^{-1}$, and 637 $cm^{-1}$ by 21 $cm^{-1}$. The authors put forward an explanation for this. The molecular model of $C_{3h}$ symmetry for boric acid, arrived at from X-ray and electron diffraction data, accounts satisfactorily for the observed infrared and Raman spectra for $B(OH)_3$. In the main the authors agree, in their interpretations, with Bethel and Sheppard (Abstr. 3568/1955). C.R.S.Manders

535.338.333

6990. STRUCTURE OF THE RESONANCE LINE OF THE ARC SPECTRUM OF BARIUM. D.A.Jackson.
Phys. Rev., Vol. 106, No. 5, 948-52 (June 1, 1957).

The structure of the line 5535 A, $6s^2\ ^1S_0$–$6s6p\ ^1P_1$, of Ba I has been investigated by means of a multiple atomic beam of high collimation (28 : 1) and a single Fabry–Perot etalon with a spectral range of 62.5 mK (1 mK = $10^{-3}$ $cm^{-1}$); the combined instrumental and Doppler width was approximately 2 mK. The line was found to have four well resolved components at 0.0, +3.8, +9.9, and +18.4 mK with apparent intensities of approximately 20 : 4.5 : 2.5 : 1. This result is consistent with that of Kopfermann and Wessel (Abstr. 4643/1949; 5658/1952) who, using a single atomic beam of collimation 10 : 1, found a structure consisting of a strong main component with wing extending to about +25 mK, but it cannot be reconciled with the results of Arroe obtained by comparing wavelengths of the line emitted by enriched isotopes in a hollow-cathode tube. This structure can be explained in terms of isotope shifts alone but the differences between the observed and calculated intensities are rather large; a more satisfactory explanation can be obtained if a small h.f.s. (10 mK) is assumed for the odd isotopes. A.

535.338.334

6991. PRESSURE BROADENING IN THE ARGON SPECTRUM. K.Lang.
Acta phys. Austriaca, Vol. 11, No. 1, 76-87 (1957). In German.

Continuation of earlier work on neon (Abstr. 6383/1952). An experimental study of a group of argon lines showed that the half-width was proportional to the gas pressure in the range 0-200 mm Hg, the pressure broadening being much more pronounced for the $1\ s_2$ ($4\ ^1P_1$) lines. There is also a larger isotope shift for these lines but a causal relation between the two effects cannot exist because natural argon consists almost entirely (99.63%) of a single isotope. E.A.Mussett

535.338.4 : 539.132

6992. ON THE CALCULATION OF INTENSITIES OF BANDS IN DIATOMIC SPECTRA (FOR THE HARMONIC OSCILLATOR). DEVELOPMENT IN A CONVERGING SERIES FOR THE PARTICULAR CASE $\omega_1 = \omega_2$. J.Ruamps.
C.R. Acad. Sci. (Paris), Vol. 244, No. 2, 184-7 (Jan. 7, 1957). In French.

See Abstr. 5171 (1957).

535.34.07 : 551.521.3

RATIO-RECORDING SYSTEM FOR THE JOHNS HOPKINS 100-FOOT ABSORPTION CELL. See Abstr. 6769

535.343 : 523.67

6993. ANALYSIS OF THE SPECTRUM OF AMMONIA ACCORDING TO OBSERVATIONS MADE IN THE LABORATORY, AND THE STUDY OF THE SPECTRA OF COMETS. P.Proisy.
Ann. Phys. (Paris), Ser. 13, Vol. 1, 745-64 (Sept.-Oct., 1956). In French.

Laboratory spectra obtained under a variety of physical conditions are compared, and classified according to the presence or absence of certain characteristic groups of emission lines. Identification of a great number of these in the spectra of comets has greatly added to our detailed knowledge of these celestial bodies. D.R.Barbei

535.343 : 537.312.5

ABSORPTION EDGE IN $HgI_2$. See Abstr. 6186

535.343

6994. ABSORPTION SPECTRA OF CERTAIN NITROGEN-CONTAINING HETEROCYCLIC COMPOUNDS AT LOW TEMPERATURES. A.N.Nikitina and G.S.Ter-Sarkisyan.
Optika i Spektrosk., Vol. 1, No. 3, 378-86 (1956). In Russian.

A study was made of the absorption spectra at −195°C and −259°C of pyridine, quinoline, acridine and derivatives thereof, some 10 substances in all. Substituting a nitrogen atom for a carbon atom in these liquid atomic compounds was not found to cause marked change in the electron shells of the molecules. C.R.S.Manders

535.343

6995. ABSORPTION SPECTRA OF BENZENE HOMOLOGUES. II. LIGHT ABSORPTION BY MONOALKYLBENZENES. V.L.Broude.
Optika i Spektrosk., Vol. 1, No. 3, 387-92 (1956). In Russian.

Pt I of this research deals with the absorption spectrum of hexamethylbenzene and is reported in Dokl. Akad. Nauk SSSR, Vol. 89, 415, (1953). The present paper is concerned with observations, at low temperatures and in polarized light, on the absorption spectra of toluene, ethylbenzene and n-hexylbenzene. Comparison of the absorption spectra of crystalline modifications of these components shows the existence of two mutually perpendicular polarized transitions in the molecules. C.R.S.Manders

535.343

6996. THE VACUUM ULTRAVIOLET ABSORPTION SPECTRUM OF NITROGEN. N.Astoin and J.Granier.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1350-3 (March 4, 1957). In French.

The $N_2$ absorption spectrum has been studied in the region 150 A-1000 A and the results compared with those of other workers. The curves obtained have been tentatively interpreted in terms of ionization and dissociation phenomena. L.Bovey

535.343 : 532.77

6997. INTERACTION BETWEEN SULFUR DIOXIDE AND POLAR MOLECULES. I. SYSTEMS CONTAINING ALIPHATIC ALCOHOLS, ETHERS OR BENZENE IN CARBON TETRACHLORIDE. P.A.D.de Maine.
J. chem. Phys., Vol. 26, No. 5, 1036-41 (May, 1957).

The absorption band of sulphur dioxide near 2800 A in mixed solvents of benzene, aliphatic alcohols, or ethers with carbon tetrachloride is probably in part the result of a donor–acceptor complex with sulphur dioxide as acceptor. The characteristic constants for the MeOH, EtOH, n-PrOH, n-BuOH, and benzene complexes with sulphur dioxide and the heats of formation of the benzene and ethanol complexes with sulphur dioxide in carbon tetrachloride have been estimated. The effect of atmospheric water vapour on these systems is also discussed. A.

535.343 : 532.77

6998. INTERACTION BETWEEN SULFUR DIOXIDE AND POLAR MOLECULES. II. SYSTEMS CONTAINING ETHANOL AND BENZENE OR HYDROQUINONE. P.A.D.de Maine.
J. chem. Phys., Vol. 26, No. 5, 1042-9 (May, 1957).

The near ultraviolet absorption for sulphur dioxide in benzene–ethanol solvent is adequately explained as arising from the superimposed bands for the systems:

$$EtOH + SO_2 \underset{K_1}{\rightleftharpoons} (complex)_1;\quad Benzene + SO_2 \underset{K_2}{\rightleftharpoons} (complex)_2,$$

if it is assumed that in passing from nonpolar to polar solvents there is no change in $K_1$, $K_2$, and in the molar extinction coefficients of the two complexes and of the uncombined sulphur dioxide. Extinction coefficients and equilibrium constants for the benzene complex must be obtained from analysis of solutions with high benzene concentration. It was found that the thermodynamic constants of both complexes, calculated from data for the mixed system, are identical with values obtained for the separate systems with carbon tetrachloride. A similar analysis of the absorption spectra of hydroquinone–sulphur dioxide–ethanol solutions gives a value of 14.0 ± 1.0 kcal per mole for the heat of formation of the hydroquinone–sulphur dioxide complex in ethanol. The heat of decomposition of the solid hydroquinone–sulphur dioxide clathrate compound

was found, by Wynne-Jones and Anderson, to be 14.2 ± 0.1 kcal. These results demonstrate the importance of lattices in polar solvents. A.

535.343 : 532.77

6999. INTERACTION BETWEEN SULFUR DIOXIDE AND POLAR MOLECULES. III. WATER-ETHANOL-SULFUR DIOXIDE AND WATER-SULFUR DIOXIDE SYSTEMS. P.A.D.de Maine.
J. chem. Phys., Vol. 26, No. 5, 1049-56 (May, 1957).

It is shown that the temperature dependence of the ultraviolet absorption spectra for water–sulphur dioxide solutions cannot be explained by the theories of Ley and Konig or Boyd-Campbell and Maass. Qualitative arguments show that the mechanism, $(SO_2)_{gas} \rightleftharpoons SO_2 + H_2O \rightleftharpoons \text{complex} \rightleftharpoons H_2SO_3 \rightleftharpoons H^+ + {}^-HSO_3 \rightleftharpoons 2H^+ + {}^{-2}SO_3$, does explain the spectroscopic behaviour of dilute sulphur dioxide solutions. A linear relation is reported between the heat of solution, calculated from vapour pressure data, and the smallest effective molecular diameter of several gases. Attempts to analyse the absorption spectra of the water–ethanol–sulphur dioxide solutions in terms of the separate systems, $EtOH + SO_2 \rightleftharpoons \text{complex}_1$ and $(SO_2)_{gas} \rightleftharpoons SO_2 + H_2O \rightleftharpoons \text{complex}_2 \rightleftharpoons H_2SO_3 \rightleftharpoons H^+ + {}^-HSO_3$ are reported. These reports are explained by the new liquid lattice theory. A.

535.343

7000. INTERPRETATION OF ABSORPTION SPECTRA OF ANIONS. E.M.Kosower, R.L.Martin and V.W.Meloche.
J. chem. Phys., Vol. 26, No. 5, 1353 (May, 1957).

The ultraviolet absorption maximum of the iodide ion is moved to longer wavelengths on solution in solvents which contain a bond system which can accept an electron. This is thought to be due to formation of a charge-transfer complex. G.I.W.Llewelyn

535.343

7001. PERTURBATIONS OF THE NEAR ULTRAVIOLET ABSORPTION SPECTRA OF THE VAPOURS OF SEVERAL MONOSUBSTITUTED HALOGEN DERIVATIVES OF BENZENE BY INERT GASES COMPRESSED TO 1500 kg/cm$^2$. B.Oksengorn.
C.R. Acad. Sci. (Paris), Vol. 244, No. 5, 574-7 (Jan. 28, 1957). In French.

Displacements occurring in the spectra of $C_6H_5F$, $C_6H_5Cl$ and $C_6H_5Br$ when the vapours are compressed with $N_2$ and also with argon at 20°C are reported. The displacements and the half-band widths are linear functions of the density of the inert gas. The shifts are greater for $N_2$ than for argon, and the difference in the intermolecular fields are insufficient to account for this. G.Allen

535.343 : 535.333

7002. SPECTRA OF THE EXCITON, IN ABSORPTION AND EMISSION, IN γ-AgI AT VERY LOW TEMPERATURES.
G.Perny and S.Nikitine.
C.R. Acad. Sci. (Paris), Vol. 244, No. 7, 878-81 (Feb. 11, 1957). In French.

The spectra are studied at 77°, 20° and 4°K. Lines forming hydrogen-like series near λ = 4000-4500 A are attributed to an exciton. The emission lines are displaced about 390 cm$^{-1}$ towards lower wave numbers; the lower energy levels giving rise to emission lines are attributed to polarization of the lattice by the exciton. G.F.Lothian

535.343 : 535.37

7003. FORM OF ABSORPTION AND LUMINESCENCE BANDS OF COMPLEX [PHTHALIMIDE] MOLECULES.
B.I.Stepanov and L.P.Kazachenko.
Dokl. Akad. Nauk SSSR, Vol. 112, No. 6, 1027-9 (1957). In Russian.

535.343

7004. INFRARED SPECTRA BEYOND 20μ. I. PRISM SPECTROGRAPHS. J.Lecomte.
Cahiers de Phys.,No. 77, 1-11 (Jan., 1957). In French.

A review of work carried out in the author's laboratory in the 20-50 μ region using prism spectrographs. R.C.Seymour

535.343

7005. INFRARED SPECTRA BEYOND 20 μ. II. GRATING SPECTROMETERS. A.Hadni.
Cahiers de Phys., No. 77, 12-24 (Jan., 1957). In French.

For Pt I, see preceding abstract. A review of the far infrared field, particularly of pure rotational spectra, deformation and torsional vibrations. The use of gratings to achieve required resolution is discussed. R.C.Seymour

535.343 : 539.133

7006. PURE ROTATIONAL SPECTRA OF THE PARTIALLY DEUTERATED AMMONIAS IN THE FAR INFRARED SPECTRAL REGION. E.D.Palik and E.E.Bell.
J. chem. Phys., Vol. 26, No. 5, 1093-101 (May, 1957).

Rotational spectra of $NH_2D$ and $NHD_2$ have been measured in the spectral range from 30 to 200 cm$^{-1}$. The inversion splitting of the $NH_2D$ lines has been observed. The spectra have been analysed to obtain term values for many of the low J rotational levels of the ground states of those molecules. The effects of centrifugal distortion on the energy levels is discussed. Molecular constants and dimensions are obtained. A.

535.343

7007. INFRARED SPECTRUM OF HEXADEUTEROBENZENE–IODINE SOLUTION. E.E.Ferguson.
J. chem. Phys., Vol. 26, No. 5, 1357-8 (May, 1957).

The increase in the intensity of the $C_6D_6$ infrared bands at 944 cm$^{-1}$ and 662 cm$^{-1}$ upon addition of $I_2$ are consistent with the changes already reported (Abstr. 2035/1957) in the $C_6H_6$ spectrum caused by $I_2$ and $Br_2$. This supports the postulation of $C_{6v}$ axial symmetry for the benzene–halogen charge transfer complexes. G.I.W.Llewelyn

535.343 : 541.183

CHANGES IN THE INFRA-RED SPECTRA OF MOLECULES DUE TO PHYSICAL ADSORPTION. See Abstr. 6669

535.343

7008. STUDY OF THE HALF-WIDTHS OF MICROWAVE ABSORPTION LINES OF AMMONIA.
A.A.Kolosov and L.L.Myasnikov.
Optika i Spektrosk., Vol. 1, No. 3, 374-7 (1956). In Russian.

Measurements were made over the range 2 x 10$^{10}$-3 x 10$^{10}$ c/s of the variation with pressure, from 0.1 and 0.001 mm Hg, of the half-widths of the (1,1), (3,3), (4,4) and (9,8) inversion spectrum lines of ammonia. With increase of intensity an increase in line half-width is found in accordance with theory due to Lamb. Results are also given of measurements on the hyperfine structure of $N^{14}H_3$ absorption lines. C.R.S.Manders

535.343 : 539.133

7009. MICROWAVE SPECTRUM AND STRUCTURE OF PROPIONITRILE. R.G.Lerner and B.P.Dailey.
J. chem. Phys., Vol. 26, No. 3, 678-80 (March, 1957).

Rotational transitions of several isotopic species of propionitrile have been observed. The has permitted a determination of the structural parameters of the molecule. For $C_2H_5C^{12}N$, B = 4714.00 Mc/s, C = 4235.07 Mc/s and for $C_2H_5C^{13}N$, B = 4689.77 Mc/s and C = 4214.87 Mc/s. For $CD_3CHDC^{12}N$, B = 4169.43 Mc/s and C = 3736.83 Mc/s. The following model reproduces these constants to within 1.5 Mc/s : $r_{C-C}$ = 1.5479 A (ethyl), $r_{C-C} \doteq$ 1.4735 A (nitrile), $r_{C\equiv N}$ = 1.1566 A, $r_{C-H}$ = 1.0914 A, $\angle CCC = 110°32'$, $\angle HCH = 109°19'$. The height of the barrier to internal rotation has been estimated to be 1150 ± 100 cm$^{-1}$ or 3280 ± 290 cal/mole for a torsional frequency of 226 cm$^{-1}$. A

535.343 : 539.133

7010. MICROWAVE SPECTRUM AND STRUCTURE OF FORMIC ACID. R.G.Lerner, B.P.Dailey and J.P.Friend.
J. chem. Phys., Vol. 26, No. 3, 680-3 (March, 1957).

The microwave spectra of five isotopic species of formic acid have been investigated, and values of the rotational constants B and C have been obtained. For $HC^{12}OOH$, B = 12 055.1 Mc/s, C = 10 416.0 Mc/s; for $HC^{12}OOD$, B = 11 762.5 Mc/s, C = 9970.1 Mc/s; for $DC^{12}OOH$, B = 12 055.6 Mc/s, C = 9955.8 Mc/s; for $DC^{12}OOD$, B = 11 759.9 Mc/s, C = 9534.1 Mc/s; and for $HC^{13}OOH$, B = 12 053.7 Mc/s, C = 10 378.9 Mc/s. The following structural parameters have been fitted to these rotational constants: $r_{C-H}$ = 1.085 A, $r_{C=O}$ = 1.245 A, $r_{C-O}$ = 1.312 A, $r_{O-H}$ = 0.95 A, $\angle OCO = 124°18'$, $\angle COH = 107°48'$. The C=O bond has been estimated to have 75% double-bond character. The torsional frequency was found to be 667 ± 41 cm$^{-1}$ and a barrier height of roughly 17 kcal/mole is indicated. A

535.343

7011. MICROWAVE ABSORPTION IN ETHYL CHLORIDE.
Krishnaji and G.P.Srivastava.
Phys. Rev., Vol. 106, No. 6, 1186-90 (June 15, 1957).

The variation of the microwave absorption coefficient with pressure in ethyl chloride has been determined at 7392 Mc/s and 8780 Mc/s. The values at one atmosphere pressure and temperature 300°K are 4.9 x 10$^{-4}$ cm$^{-1}$ and 6.9 x 10$^{-4}$ cm$^{-1}$, respectively. From the known values of the rotational constants of the molecule, all the allowed rotational frequencies of the P, Q, and R branches for all significant J values have been computed; the theoretical intensities of these lines have been computed approximately with the help of the transition intensities tabulated by Cross, Hainer, and King. The formula of Van Vleck and Weisskopf has been used to calculate the absorption due to these lines, and it is found that practically all

the absorption observed in the 3 cm and 1.25 cm regions is due to the low-frequency Q-branch rotational lines, most of which are practically at zero frequency because the asymmetry in the molecule is very small. The value of the pressure-broadening parameter which gives the best fit in the experimental data at all pressures up to one atmosphere is 0.25 $cm^{-1}$ per atmosphere. The observed absorption is thus equivalent to a Debye-type nonresonant absorption due to a zero-frequency line of intensity $22.83 \times 10^{-4}$ $cm^{-1}$/atm and $\Delta\nu = 0.25$ $cm^{-1}$/atm. A.

535.345 : 539.23

7012. QUALITATIVE STUDY OF THE TRANSMISSION SPECTRA OF THIN FILMS OF CuI AT 77°K AS A FUNCTION OF THEIR THICKNESS. S.Nikitine and R.Reiss.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1478-81 (March 11, 1957). In French.

The thicknesses ranged from several $\mu$ to 0.05$\mu$; the continuous absorption band in the visible and near u.v. vanishes for the thinner films but several sharp absorption lines are then revealed. The difficulties of interpreting this result are pointed out. E.A.Mussett

535.37 : 539.11

7013. DISTURBANCES IN THE TRANSFER OF EXCITATION ENERGY IN A SOLID SOLUTION OF NAPHTHACENE IN ANTHRACENE. A.N.Faĭdyš, I.Ya.Kucherov and A.A.Terskiĭ.
Optika i Spektrosk., Vol. 1, No. 3, 403-6 (1956). In Russian.

Experiments were made with three different sizes of anthracene particle and it was confirmed that with diminution of size there is reduction in the time of migration of energy. Admixture of optically neutral impurities affected the phenomenon in the same manner. With lowering of temperature it was established that there is considerable lessening of effectiveness of transfer of energy from the base substance to the impurity. C.R.S.Manders

535.37

7014. LUMINESCENCE OF SILVER BROMOIODIDE CRYSTALS. F.Moser and F.Urbach.
Phys. Rev., Vol. 106, No. 5, 852-8 (June 1, 1957).

Crystals of simple and mixed silver halides are known to show a strong fluorescence but little afterglow at low temperatures. However, the slow buildup of luminescence under weak excitation indicates the presence of effective trapping processes. These processes have been studied in more detail on silver bromoiodide crystals. The lifetimes of the trapping states were estimated by observing the dependence of buildup rates on the dark interval between two exposures. The trapping states are also revealed by the effects of infrared radiation. If applied during excitation, it reduces the stationary brightness; if it is applied in the interval between exposures, it reduces the rate of re-excitation. The pattern of behaviour of these phosphors is interpreted by a model of the type generally used in the description of zinc sulphide and similar photoconducting phosphors. If the absence of afterglow is taken into account, the model requires that the efficiency of the phosphor should increase with the square root of the exciting intensity. This has been confirmed experimentally over a range of 3 powers of 10. An afterglow can be produced in the silver bromoiodide by incorporating certain divalent cations (such as Cd++ or Sr++) into the crystal. From an extension of the model to this more complex system, a number of emission and stimulation effects can be deduced which have been found in a series of qualitative observations. A.

535.37 : 548.7

LUMINESCENCE OF COLOUR CENTRES. See Abstr. 6727

535.371

7015. THE LUMINESCENCE OF COLOUR CENTRES IN KCl. K.H.Becker and H.Pick.
Nachr. Akad. Wiss. Göttingen, Math.-Phys. Kl. IIa, No. 7, 167-72 (1956). In German.

Additively coloured KCl crystals illuminated with the Hg green line showed emission in the infrared at temperatures in the range from −200°C to −50°C. The spatial distribution and the quantum yield were also measured. The results are briefly discussed. J.E.Caffyn

535.371

7016. ON THE ENERGY DEPENDENCE OF FLUORESCENCE OF POLYCRYSTALLINE PHOSPHORS EXCITED BY ELECTRON BEAMS AND BY X-RAYS. D.Messner.
Z. Phys., Vol. 147, No. 1, 24-42 (1957). In German.

The response of certain phosphors to mono-energetic electrons between 5 and 45 keV was measured. Organic specimens show a non-linear behaviour and departures are also found for ZnS-Ag and $CaWO_4$. RbI shows a linear response. The dependence of luminescence yield on exciting X-ray wavelength was measured in the region 0.078 to 0.4 kX. G.F.J.Garlick

535.371

7017. ON THE LUMINESCENCE OF THE ALKALI VANADATES. H.Gobrecht and G.Heinsohn.
Z. Phys., Vol. 147, No. 3, 350-60 (1957). In German.

Alkali metavanadates fluoresce under near ultraviolet, the efficiency increasing steeply from the Li salt (nil), Na (slight) to Cs (as bright as ZnCdS). Emission peaks are mostly in the yellow or green, their wavelength decreasing with increasing atomic weight of alkali metal, similarly for the excitation peak near 4000 A. Other data are given on the emission at −183°C, on absorption spectra, on temperature–brightness curves (with maximum output for the Rb and Cs salts below −100°C), on the very small photoconductivity and the exponential decay constants. To cathode-rays $CsVO_3$ is roughly 10 times less efficient than sulphide phosphors. S.T.Henderson

535.375.5

7018. MODIFICATION OF THE RAMAN SPECTRUM OF A SUBSTANCE WHEN THE EXCITING FREQUENCY BECOMES VERY NEAR A RESONANCE FREQUENCY. R.Lennuier.
C.R. Acad. Sci. (Paris), Vol. 244, No. 8, 1022-4 (Feb. 18, 1957). In French.

Placzek's theory shows that in this case, the intensities of Raman lines, especially of harmonics and combinations of fundamental vibrations, is considerably increased. Benzene excited by $\lambda$ = 2537 A is briefly considered. G.F.Lothian

535.375.5

7019. PHOTOELECTRIC DETECTION OF THE RAMAN EFFECT. F.Valentin.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1915-17 (April 1, 1957). In French.

The source is a mercury lamp fed by condenser discharges at 50 flashes per second. The Raman spectrum is scanned by a photomultiplier and amplifier, in which the noise is reduced by having it short-circuited except during the times of light emission. G.F.Lothian

535.375.54

7020. RAMAN SPECTRA OF WATER IN SOME HYDRATED CRYSTALS. A.Weil-Marchand.
C.R. Acad. Sci. (Paris), Vol. 244, No. 5, 582-4 (Jan. 28, 1957). In French.

Hydrated crystals of $MgCl_2$ $Zn(BrO_3)_2$ and $BeSO_4$ are examined down to −140°C. In some cases the vibrations of $H_2O$ are resolved into several components by the coupling between the molecules; interpretations are discussed. G.F.Lothian

535.375.54

7021. STUDY OF THE RAMAN SPECTRA OF MONOCRYSTALS OF ORDINARY ROCHELLE SALT AND OF THE DEUTERATED COMPOUND. A.M.Laroche and J.Chapelle.
C.R. Acad. Sci. (Paris), Vol. 244, No. 7, 876-8 (Feb. 11, 1957). In French.

The compounds studied are $NaK(CO_2{-}CHOH)_2.4H_2O$ and $NaK(CO_2{-}CHOD)_2.4D_2O$. The frequencies are mostly nearly identical; but the frequencies near 3300 $cm^{-1}$ have counterparts in the deuterated compound lower by about $\sqrt{2}$ and these are attributed to the OH (and OD) group. The absence of lower frequencies in this ratio indicates that deformation vibrations of $H_2O$ are not manifest. G.F.Lothian

535.376

7022. THE LIGHT OUTPUT OF SOME PHOSPHORS EXCITED WITH ELECTRONS OF HIGH CURRENT DENSITY. P.A.Einstein.
Brit. J. appl. Phys., Vol. 8, No. 5, 190-4 (May, 1957).

The behaviour of phosphors at high current densities and at 50 kV has been examined using a pulse technique. For a number of phosphors, the onset of saturation occurs at a high value of current density (in the region of $10^{-1}$ A/$cm^2$). Significant phosphor heating was avoided by use of single pulses of short duration, and did not become important up to current densities of 1 A/$cm^2$. The rise and decay time constants (though the processes are not exponential) in general increase with current density as has also been reported by other workers for lower current densities. Empirical laws relating time constants to current density have been established. A.

535.376

7023. THE HEATING OF FLUORESCENT SCREENS BOMBARDED BY ELECTRONS. G.D.Archard and P.A.Einstein.

Brit. J. appl. Phys., Vol. 8, No. 6, 232-6 (June, 1957).

The temperature rises of fluorescent screens under various forms of electron bombardment (such as pulsed or scanned beams) are calculated in terms of screen dimensions and the thermal constants of the phosphor. Fair agreement is found between theory and experiment. Worked examples relating to practical cathode-ray tubes are given. A.

535.39

7024. THE DETERMINATION OF THE OPTICAL CONSTANTS OF NEODYMIUM IN THE VISIBLE AND NEAR INFRARED. E.Kern.
Z. Phys., Vol. 148, No. 1, 38-52 (1957). In German.

The optical constants of Nd were evaluated at wavelengths between 3950 A and 8800 A by measurement of the radiation transmitted and reflected by evaporated layers. The results are discussed with reference to the electron theory of metals. The absorption is due to three overlapping bands, the central one having a width of 1 eV and an oscillator strength of 0.025. It is not possible to identify this band with a particular electronic transition. It is estimated from the dispersion data that there is 0.1 free electron per Nd atom, in good agreement with a value obtained from the electrical conductivity. The influence of the 4 f-electrons on the optical properties of the metal and of ionic crystals containing $Nd^{+++}$ ions is discussed.

C.Hilsum

535.393

7025. THE EXPERIMENTAL STUDY OF THE OPTICAL PROPERTIES OF METALS AND THE RELATION OF THE RESULTS TO THE DRUDE FREE ELECTRON THEORY. L.G.Schulz.
Advances in Phys., Vol. 6, 102-44 (Jan., 1957).

Review of recently developed experimental methods and of results on the optical constants of a number of liquid and solid metals and alloys. Comparison is made with the Drude theory, including the extension to deal with the anomalous skin effect. 125 references. E.H.Sondheimer

535.393 : 539.234

7026. THE REFLECTIVITY OF THIN SILVER FILMS PREPARED BY SLOW EVAPORATION. M.Perrot and J.Tortosa.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1347-50 (March 4, 1957). In French.

Measurements were first made in vacuo, during the preparation of the films, which were deposited at a rate of 200 A/hr. Three wavelengths were used, 4358, 5461 and 5780 A. The pressure was subsequently raised to atmospheric and changes in the reflectivity observed. From the results conclusions regarding the optimum conditions of preparation and measurement are drawn.

D.G.Avery

535.393

7027. OPTICAL INVESTIGATIONS ON POTASSIUM LAYERS OF ATOMIC THICKNESS. A.W.Elbel.
Z. Phys., Vol. 147, No. 4, 465-80 (1957). In German.

Results are obtained for the dependence of optical transmission of potassium layers on layer thickness and are compared with data for photoelectric response. A maximum occurs in the response for a layer of $\sim 2 \times 10^{15}$ atoms per $cm^2$. The absorption product (nk) is determined for the layers in the 0.4 - 0.5 $\mu$ wavelength region.

G.F.J.Garlick

535.412

7028. SOME ANOMALIES SHOWN BY THE INTERFERENCE FRINGES OBTAINED WITH SEMIREFLECTING LAYERS IN THE INFRARED. J.Vincent-Geisse and J.Lecomte.
C.R. Acad. Sci. (Paris), Vol. 244, No. 16, 2152-5 (April 15, 1957). In French.

A simple theory is outlined which accounts satisfactorily for the observed visibilities and positions of the interference fringes in the infrared transmission spectrum of a Fabry–Perot type filter. E.A.Mussett

535.417

7029. ON THE FUNCTIONING OF A WOLLASTON DOUBLE-IMAGE PRISM FOR DIFFERENTIAL INTERFEROMETRY IN POLARIZED LIGHT. G.Gontier.
C.R. Acad. Sci. (Paris), Vol. 244, No. 8, 1019-21 (Feb. 18, 1957). In French.

Extends the theory of an earlier paper (Abstr. 8706/1956). Describes how to determine from observed fringes the deviations produced by an isotropic plate. G.F.Lothian

535.42

7030. DIFFRACTION OF LIGHT WAVES BY AN INFINITE PARALLEL SLIT AND BY A HALF-PLANE. Phan Van-Loc.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1470-3 (March 11, 1957). In French.

The Maggi formula is used to obtain the wave diffracted by a slit when this is illuminated by a point source or a line source parallel to the slit. A half-plane is considered as a special case in which one of the slit edges is removed to infinity. E.A.Mussett

535.42 : 548.7

AN OPTICAL DIFFRACTION METHOD OF STUDYING IMPERFECT CRYSTALS. See Abstr. 6721

535.434

7031. THEORETICAL INVESTIGATIONS ON THE LIGHT SCATTERING OF COLLOIDAL SPHERES. III. ANALYTICAL EXPRESSIONS FOR TURBIDITY APPROXIMATING THE PERFORMANCE OF THE MIE EQUATIONS PRIOR TO THE FIRST MAXIMUM. W.Heller.
J. chem. Phys., Vol. 26, No. 5, 1258-64 (May, 1957).

For Pt II see Abstr. 5254 (1957). Analytical expressions are developed for the specific turbidity in dispersed systems of light scattering spheres. They yield particle diameters approximating over an appreciable range of $\alpha$ and m values and within better than 5% those obtained from the Mie equations. The m range encompassed satisfactorily by the equations exceeds appreciably the range of validity of the Rayleigh–Gans and Debye equations. The limiting lower and upper values of $\alpha$ and m to which the equations are applicable, are defined quantitatively. A.

535.435/.436

7032. ON THE SUBJECT OF THE INFLUENCE OF THE APERTURE OF THE INCIDENT BEAM ON THE DEPOLARIZATION FACTOR OF THE LIGHT SCATTERED BY MOLECULES.
A.Ivanoff and J.Lenoble.
C.R. Acad. Sci. (Paris), Vol. 244, No. 3, 329-31 (Jan. 14, 1957). In French.

An expression for the depolarization ($\rho$) is calculated and is plotted as $\rho$ against the semi-angle of the cone of the incident beam (up to 90°) for angles of 0°, 30°, 60° and 90° between the scattered radiation and the axis of the incident cone. G.F.Lothian

535.435

7033. ON THE SCATTERING OF LIGHT IN LIQUIDS. THE ATTEMPTS TO DETERMINE THE RAYLEIGH CONSTANT IN BENZENE. J.Cabannes.
Ann. Phys. (Paris), Ser. 13, Vol. 1, 857-69 (Nov.-Dec., 1956). In French.

A careful recapitulation of the Einstein–Smoluchowski density fluctuation theory of scattering by anisotropic molecules. The effect of fluctuations in the molecular field is neglected but amounts to only a few per cent. The final expression gives a correct value for N when the lower (see Abstr. 368/1954) of the various experimental values for the Rayleigh ratio of benzene is substituted.

G.F.Lothian

535.435 : 532.74

7034. STUDY OF RAYLEIGH SCATTERING BY SUPERCOOLED BENZOPHENONE. L.Taurel and B.Launay.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1354-5 (March 4, 1957). In French.

Comparison of the intensities of scattered radiation for different polarizations of incident and scattered beams indicates the presence of large molecular groups whose disappearance with various heat treatments is followed. G.F.Lothian

535.511

7035. GENERALIZED THEORY OF INTERFERENCE, AND ITS APPLICATIONS. I. COHERENT PENCILS. S.Pancharatnam.
Proc. Indian Acad. Sci. A, Vol. 44, No. 5, 247-62 (Nov., 1956).

Expressions are developed for the intensity of (a) two, (b) n superposed beams of elliptically polarized light, and (c) two elliptically polarized beams passed through an analyser consisting of a $\lambda/4$ plate and a Nicol. In (a) the state of polarization is also deduced. Throughout, the parameters of the ellipses are expressed in terms of the Poincaré sphere and some theorems on the general properties of this are deduced. G.F.Lothian

535.7

PHYSIOLOGICAL OPTICS. VISION. See under "Medical science. Human physiology". Decimal classification 612.84

535.81

7036. EXTREME WIDE-ANGLE OBJECTIVES.
F.I.Havliček.
Bull. sci. Cons. Acad. Yougoslavie, Vol. 3, No. 2, 38-9 (Dec., 1956). In German.

Constructional data are given for two systems, covering angles of 200° and 360°. Each consists of a simple front meniscus element and a positive rear meniscus element. Graphs of the residual aberrations are reproduced. R.W.Fish

535.81 : 535.323

7037. REFRACTIVE INDICES [n] AND DISPERSIONS [$\nu$] OF GLASSES BASED ON SULPHIDES, SELENIDES AND TELLURIDES. A.Winter.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 750-2 (Feb. 4, 1957). In French.

The first two types give glasses with large n and small $\nu$, probably telluride glasses are similar. G.F.Lothian

535.822.17

7038. FRINGE SPACING IN INTERFERENCE MICROSCOPES. J.W.Gates.
J. sci. Instrum., Vol. 33, No. 12, 507 (Dec., 1956).

In high-power interference microscopes fringe spacing is greater than half a wavelength, depending on the numerical aperture, and this arises from obliquity of incident light, when a converging beam is used. A formula is derived, and predictions are compared with observations for N.A. values 0.30, 0.60 and 0.65. There is close agreement. S.Tolansky

535.822.17

7039. OBLIQUITY EFFECTS IN INTERFERENCE MICROSCOPES. C.F.Bruce and B.S.Thornton.
J. sci. Instrum., Vol. 34, No. 5, 203-4 (May, 1957).

A theoretical analysis is made of the influence of oblique rays on the fringes produced with interference microscopes. The convergency of the light, which is determined by the numerical aperture of the objective, results in the fringes being displaced from the position for ideally collimated light at normal incidence. The analysis accounts fairly well for measurements of step heights with microscopes of different numerical apertures by Tolman and Wood. The correction due to obliquity is of the order of 10% and over a limited range of step heights, a simple correction rule of $\alpha^2/4$ per unit is satisfactory to about 2%, where $\alpha = \sin^{-1}(\text{n.a.})$. The more rigorous formula shows a nonlinear relation between obliquity-correction and step-height. A.

535.822.17

7040. PHASE—FLUORESCENCE MICROSCOPY. Y.T.Tchan.
Nature (London), Vol. 179, 1243-4 (June 15, 1957).

By adding two polarizing rings into a phase microscope, it is possible to control the light intensity of the phase image, and in fluorescent microscopy, the relative intensities of the fluorescent image and the phase image. The arrangement can also be useful in bright-field microscopy. R.W.Fish

535.826.3

7041. AN ULTRA-MICROTOME. A.L.Sims and T.S.Leeson.
J. sci. Instrum., Vol. 34, No. 5, 185-6 (May, 1957).

The instrument is so designed that it can be made in a laboratory workshop where a lathe and a milling or shaping machine are available. The body of the machine is made of a metal with very small coefficient of expansion and carries both the knife and the specimen-holder. The coefficient of expansion of the latter is six and a half times that of the body of the machine and the specimen is moved over the knife by heating this holder. A clear visual field is provided for the operator to cut sections under a binocular microscope. Provision is made for easy handling of the cut sections. To avoid vibration while cutting, the specimen holder is rotated magnetically. Cutting is fully automatic and sections of $1/40\mu$ (250 Å) can readily be obtained. A.

535.89

7042. A HIGH-INTENSITY LIGHT SOURCE FOR STROBOSCOPIC OPERATION AT FREQUENCIES UP TO 250 kc/s. M.D.Dudley, I.Whitney and R.Feinberg.
Nature (London), Vol. 179, 1024 (May 18, 1957).

A high-voltage cathode-ray beam may be used as a high-frequency light source. The beam excites the entire screen surface simultaneously and uniformly. The intensity and duration of the electron beam pulse is controlled by the grid. By choice of phosphor, the form of the light pulses may be made to follow that of the control signal at frequencies up to 1 Mc/s. Some practical details of light output etc. are given. R.W.Fish

535.89 : 537.527.5

RADIAL VARIATIONS OF DENSITY AND TEMPERATURE IN A XENON SUPER-PRESSURE LAMP. See Abstr. 6226

# HEAT 536

536.2

7043. ON THE MEASUREMENT OF THE THERMAL CONVECTION COEFFICIENT USING METALLIC WIRES OF DIFFERENT CHARACTERS. I.Epelboin and A.Vapaille.
C.R. Acad. Sci. (Paris), Vol. 244, No. 3, 314-16 (Jan. 14, 1957). In French.

Using the equations given in the literature to calculate the temperature from resistance measurements of various electrically heated wires and thus obtain h, the thermal convection coefficient, it appears that h depends on the material of the wire. This difference persists with very different surrounding media. A direct determination of the resistance—temperature relation for the wire surrounded with the experimental medium increases considerably the agreement in the values obtained using different wires. F.E.Hoare

536.2.02

7044. FUNDAMENTAL EQUATIONS FOR THE BALLISTIC CURVES OF HEAT (AND OF DIFFUSION) IN A FINITE HOMOGENEOUS WALL. F.Camia.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1163-6 (Feb. 25, 1957). In French.

A wall of finite thickness is considered and an instantaneous release of heat at zero time within a plane slab of thickness dx with faces parallel to those of the wall. The heat propagation in the x-direction perpendicular to the faces of the wall, initially at zero temperature, is studied and shown to be expressible in Fourier series form for the following cases: wall with isothermal faces and median source of heat; wall, with one insulated face and the other maintained at 0°; both faces, O and A, insulated, with source at O; both faces insulated, with source at distance $l$ from O and between O and A. The mathematical expressions obtained are stated to have been checked experimentally. S.Weintroub

536.2.083

7045. A STEADY STATE METHOD FOR THE RAPID MEASUREMENT OF THE THERMAL CONDUCTIVITY OF ROCKS. A.Beck.
J. sci. Instrum., Vol. 34, No. 5, 186-9 (May, 1957).

The principle of constant temperature difference is used in a divided bar type of apparatus with which a measurement of the thermal resistance of a specimen can be completed within twenty minutes. A thick guard ring is used. The diameter of the specimens is made the same as the external diameter of the guard ring, and irregularities in disks, which would cause appreciable errors in a more conventional apparatus, can be tolerated and an accuracy of ±1% for a single measurement still be obtained. A.

536.21

7046. ON THE USE OF MATRICES FOR SOLVING PERIODIC HEAT FLOW PROBLEMS. G.W.T.White.
Appl. sci. Res. A, Vol. 6, No. 5-6, 433-44 (1957).

The temperature and heat flow on one side of a wall are related to the corresponding quantities on the other side of the wall by linear equations. When these equations are put into matrix form, they lend themselves very readily to the solution of problems in which the wall consists of many parallel layers, for then the matrix representing the composite wall is obtained by multiplying together the matrices for the individual layers. The determinants of these matrices are of particular interest and their values for temperature distribution possessing plane, cylindrical and spherical symmetry are very simple and can be derived directly from the differential equation of heat conduction. An alternative use of matrices, which is useful in one and three dimensions, occurs in problems involving temperature waves in multilayer solids where the reflection and transmission coefficients of the interfaces and the attenuation of the layers can be represented by matrices. Again the determinants of these matrices are shown to have a particularly simple value. A.

536.21 : 537.323 : 537.311.33

7047. ON THERMAL CONDUCTIVITY AND THERMOELECTRIC POWER OF SEMICONDUCTORS. D.ter Haar and A.Neaves.
Advances in Phys., Vol. 5, 241-69 (April, 1956).

Theoretical physical analysis of several topical features concerning recent careful experimental results. Errors in a previous paper by the authors are pointed out and the relation of the analysis presented here to theoretical studies currently being made elsewhere is discussed. Primarily the lattice component of thermoelectric power and of thermal conductivity is investigated, due account being taken of various scattering mechanisms, but neglecting deviations from spherical energy surfaces and many-electron phenomena. Extrinsic semiconductors only are considered but the extension to intrinsic conduction would be straightforward. The validity and necessity for the use of several basic assumptions in the theory are discussed. The results of the analysis are shown to account satisfactorily for a large number of experimental results from various laboratories. The results of the analysis are in disagreement with those of Picus (1951). Herring's (1954) paper is criticized. C.A.Hogarth

536.212 : 537.312.62

7048. THERMAL CONDUCTIVITIES OF PURE METALS AT LOW TEMPERATURES. MERCURY. R.T.Webber and D.A.Spohr.
Phys. Rev., Vol. 106, No. 5, 927-33 (June 1, 1957).

The thermal conductivity of pure mercury in the normal, superconducting, and intermediate state has been measured at liquid helium temperatures and in magnetic fields up to 1000 gauss. The superconducting-state thermal conductivity conformed to the results previously reported by Hulm (Abstr. 1794/1951). In the normal state, the thermal conductivity was a very strong function of temperature, and, at temperatures below about 3°K, was strongly dependent on the applied magnetic field. In the intermediate state, an additional component of thermal resistance was present at all temperatures measured. At temperatures near $T_c$, the excess thermal resistance was quite small and in the form of two clearly resolvable maxima. As the temperature was lowered, the magnitude of the excess thermal resistance increased approximately as $(T_c/T)^5$, in agreement with Hulm, and the resolution of the two maxima was lost. Determinations of the magnitude of the excess thermal resistivity in specimens of 1.10 in. and 0.20 in. diameter showed no dependence on size. A.

536.24

7049. ON THE ITERATIVE CALCULATION OF EVAPORATION-EXCHANGERS. M.Véron.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 728-9 (Feb. 4, 1957). In French.

A fluid is cooled or condensed by a heat exchanger the surface of which is cooled by a flow of water, which is itself partly evaporated by a current of air which is warmed and made humid in consequence. The system of mathematical equations for the thermal distribution is obtained and an iterative method is briefly described for the solution. S.Weintroub

536.24

7050. ON THE SEMI-GRAPHICAL CALCULATION OF EVAPORATION-EXCHANGERS. M.Véron.
C.R. Acad. Sci. (Paris), Vol. 244, No. 7, 862-5 (Feb. 11, 1957). In French.

See preceding abstract. Curves of the humidity of the air as a function of the water and air temperatures, and of the enthalpy of the air as a function of the humidity are used to assist in the solution. S.Weintroub

536.24

7051. HEAT [TRANSFER] PROBLEMS FOR A LAMINAR CURRENT FLOWING ALONG WALLS.
L.A.Vulis and A.T.Trofimenko.
Zh. tekh. Fiz., Vol. 26, No. 12, 2709-13 (1956). In Russian.

The laminar flow of an incompressible fluid parallel to a plane wall and in a field of non-uniform temperature is considered. The appropriate equations of hydrodynamics are solved and the distribution of velocity and temperature is calculated. It is alternatively assumed that the wall insulates or that it is held at a given temperature. Results are shown graphically. R.Eisenschitz

536.25 : 536.3

7052. THE DUST-FREE SPACE SURROUNDING HOT BODIES.
W.Zernik.
Brit. J. appl. Phys., Vol. 8, No. 3, 117-20 (March, 1957).

It is generally accepted that the dust-free space around hot bodies is due to the combined action of a radiometer force and an aerodynamic force caused by convection currents but no attempt has yet been made to derive a quantitative theory. Starting from the published work on the derivation of these forces a method has been evolved for equating them and the theory is worked out quantitatively for a vertical plate and for a horizontal cylinder in terms of temperature difference and the properties of the surrounding medium. The resulting relations are in good agreement with published experimental data. A.

536.253

7053. HEAT EXCHANGE IN A FREE LAMINAR MOVEMENT OF GASES NEAR VERTICAL WALLS [TAKING ACCOUNT] OF VARYING VISCOSITY. A.A.Tanaev.
Zh. tekh. Fiz., Vol. 26, No. 12, 2714-19 (1956). In Russian.

In the theory of free convection the movement of a gas near a vertical wall is considered as a laminar boundary layer. So far no account was taken of the variation of viscosity with the temperature in the boundary layer. In the present paper it is assumed that the coefficient of viscosity is proportional to the absolute temperature; existing theories are refined accordingly. As a result, the ratio of Nusselt's and the 4th root of Grashoff's number are plotted against the temperature; agreement with experiment is fair. R.Eisenschitz

536.3

7054. NOTE ON A SIMPLE RADIOMETER DEMONSTRATION.
M.H.Edwards.
Amer. J. Phys., Vol. 25, No. 2, 119-20 (Feb., 1957).

When a radiometer vane is exposed to radiation the reflecting surface is raised in temperature. On removal of radiation source the blackened side of vane cools more rapidly than the polished side; this establishes reverse temperature gradient in the vane and leads to reversal of motion. F.E.Hoare

536.413

7055. ON THE CONNECTION BETWEEN THERMAL EXPANSION AND POTENTIAL ENERGY IN SOLIDS AND LIQUIDS.
G.Borelius.
Ark. Fys., Vol. 11, Paper 11, 217-27 (1956).

See Abstr. 1153/1956. Experimental data for a number of cubic and non-cubic metals are examined in order to test the author's formula $\Delta U/\Delta V = \frac{3}{2}\alpha$, in which $\Delta U$ is an increase in potential energy due to increased thermal fluctuations, $\Delta V$ is the corresponding increase in volume and $\alpha$ is a pressure parameter. E.H.Sondheimer

536.413

7056. THE THERMAL EXPANSION OF A GROSSULARITE GARNET. L.G.Wilson.
Austral. J. Phys., Vol. 9, No. 3, 403-5 (Sept., 1956).

The lattice constant has been determined over the range 25 to 940°C with the result $a = 11.8368 + 8.6 \times 10^{-5}t + 2.2 \times 10^{-8}t^2$ kX. Differentiation of this equation gives the thermal expansion correct to ±2% at 25°C and ±6% at 940°C. F.E.Hoare

536.413 : 548.7

MACROSCOPIC EXPANSION AND DEFECTS OF SILVER CHLORIDE. See Abstr. 6724

536.421.1 : 535.323

CONNECTION BETWEEN MELTING POINT TEMPERATURES AND REFRACTIVE INDICES OF SOME CRYSTALS. See Abstr. 6977

536.422 : 537.529 : 621.316.923

7057. EXPLOSION OF A METAL DUE TO AN ELECTRIC CURRENT. S.V.Lebedev.
Zh. éksper. teor. Fiz., Vol. 32, No. 2, 199-207 (1957). In Russian.

The destruction of metal wires at currents of $5 \times 10^5$—$5 \times 10^6$ A/cm² was investigated. Two different types of processes were observed: rupture of the melted wire into macroscopic fragments due to surface tension forces and explosion of the melted wire due to changes of its volume properties. The discontinuity of electrical conductivity occurring when W, Mo, Pt or Ni melt has been measured. A previous conclusion that the energy of the metal at which its electrical conductivity disappears is dependent on the current density is confirmed. A.

536.422.1 : 539.16.08

7058. COUNTER TUBE MEASUREMENTS ON EXPLODED WIRES. O.Balk.
Naturwissenschaften, Vol. 43, No. 22, 511 (1956). In German.

Describes experiments on the detection of radioactivity after the explosion, with a condenser-bank current surge, of thin metallic wires. Negative results were obtained, in contradiction to earlier work elsewhere. J.D.Craggs

536.423.4 : 533.7

ON THE THEORY OF CONDENSATION. See Abstr. 6946

536.46

7059. SOME RECENT DEVELOPMENTS IN THE PHYSICS OF FUEL COMBUSTION. M.W.Thring.
Brit. J. appl. Phys., Vol. 8, No. 3, 89-97 (March, 1957).

The main factors limiting combustion intensity in practical solid or liquid fuel systems are macro- and micro-mixing of fuel and air, heating the incoming fuel and heat loss from the flame. Micro-mixing leads to a combustion time proportional to the square of the initial particle or droplet diameter so that fineness of grinding or "atomization" is the prime essential. In grate firing the high relative velocity of gas and particle can give a much greater rate of micro-mixing and the particles remain in the combustion chamber until they are consumed. Macro-mixing can be predicted from isothermal models in the three cases of the high velocity fuel jet, the large preheated gaseous fuel jet and the low Reynolds number heating flue — the geometrical distortion to allow for the density change on combustion is different in the three cases. The first case which corresponds to the liquid-fuel-fired open-hearth steel-melting flame has been extensively studied to throw considerable light on the optimum design. Models can also be used for predicting the erosion of walls, the distribution of fuel residence times and the

effect of buoyancy. A method of calculating the heat transfer rate from various flames in the open hearth furnace is providing a link between the model work, and flame radiation measurements and practical operation. A.

536.461 : 518.5

THEORY OF DIFFUSION FLAMES. See Abstr. 6808

536.48

7060. PHYSICS BELOW 1°K. E.Mendoza.
Brit. J. appl. Phys., Vol. 8, No. 6, 219-28 (June, 1957).

A temperature T can only be called "low" if kT is small compared with some energy level spacing characteristic of the system. On this criterion 1°K is often not a low temperature, and the region below 1°K is one in which many events occur. The adiabatic demagnetization of paramagnetic bodies is the commonest technique for attaining these low temperatures, though other methods also exist. The main limitation on experiments is the small amount of power which can be absorbed by the working substances. At temperatures down to $3 \times 10^{-2}$ °K, a number of experiments have been performed, not only on the refrigerants but also on other substances. Results from several branches of physics, including solid state and nuclear physics, are briefly presented and discussed. Below $3 \times 10^{-2}$ °K only the refrigerants have been investigated; the lowest temperature yet reached is about $2 \times 10^{-5}$ °K. A.

536.48 : 530.162

7061. THEORY OF BOSE–EINSTEIN CONDENSATION OF AN IMPERFECT BOSE–EINSTEIN GAS. T.Matsubara, A.Morita and N.Honda.
Progr. theor. Phys., Vol. 16, No. 5, 447-54 (Nov., 1956).

In order to clarify the behaviour of the Bose–Einstein condensation, to which various investigations have been reported with results being in conflict with each other, the influence of binary collisions to the Bose–Einstein condensation is treated correctly. As the result, it is shown that the B.–E. condensation is of the third order, as in the case of an ideal Bose–Einstein gas model. A.

536.48

7062. A LATTICE MODEL FOR LIQUID HELIUM.
T.Matsubara and H.Matsuda.
Progr. theor. Phys., Vol. 16, No. 4, 416-17 (Oct., 1956).

The familiar analogy of the λ-transition of helium and the Curie point of ferromagnetics is re-formulated. The analogy is based on the simultaneous application of a lattice model and the commutation rules for the quantized amplitudes for bosons.

R.Eisenschitz

536.48

7063. A LATTICE MODEL OF LIQUID HELIUM. I.
T.Matsubara and H.Matsuda.
Progr. theor. Phys., Vol. 16, No. 6, 569-82 (Dec., 1956).

A lattice model is proposed in order to explain the peculiar properties of liquid helium II. In the present model, liquid is regarded as a lattice composed of atoms and holes. Each atom can migrate by exchanging its position with an adjacent hole if the latter exists. In terms of operators which create or annihilate an atom at each lattice point, the kinetic and potential energies are defined so as to have a correct form in the limit of vanishing lattice spacing. Then it is proved that the grand partition function of the lattice liquid is equal to the partition function of a system of vector spins subjected to an external magnetic field, provided a proper identification is made between corresponding quantities of both systems. Various approximation methods used in the problem of ferromagnets are applicable and enable results to be obtained which explain most of the characteristic features of liquid helium. A.

536.48 : 532.13

VISCOSITIES OF LIQUIDS $He^3$ AND $He^4$. See Abstr. 6927

536.48

7064. DIFFRACTION OF THERMAL WAVES IN LIQUID HELIUM II. J.E.Mercereau and J.R.Pellam.
Phys. Rev., Vol. 106, No. 6, 1113-16 (June 15, 1957).

Diffraction effects in thermal radiation have been produced in liquid helium II by means of a thermal grating radiating a primary (zero-order) beam accompanied by higher-order beams at appropriate Bragg angles. These results at once demonstrate unambiguously the true wave nature of this thermal wave propagation and its conformity to Huygens' principle in the most demanding test to which second sound has been subjected. The general nature of the angular pattern, including the fine structure, conforms to the requirements of diffraction behaviour for more customary wave motions. A determination of wave velocity ($v_2$) for second sound is obtainable from the observed Bragg angles. A.

536.483

7065. THE MAGNETIC REFRIGERATOR FOR TEMPERATURES BELOW 1°K. J.G.Daunt.
Proc. Phys. Soc. B, Vol. 70, Pt 7, 641-52 (July, 1957).

The magnetic refrigerator is a device for maintaining isothermally a reservoir and/or experimental apparatus at temperatures below 1°K. Starting from temperatures maintained by a liquid-helium bath the device produces cold by the magnetic cooling method, the cooling being performed in a cyclic manner. By cyclic operation temperatures below 1°K, as low as approximately 0.2°K, can be maintained continuously. In this paper some design problems are considered in detail and a comparison is made between the theoretically computed performance and the experimental observations on the first few magnetic refrigerators which have so far be constructed. The "engine" of the magnetic refrigerator basically requires, besides a paramagnetic working substance for the magnetic cooling process, thermal valves which may allow or block the flow of heat between the working substance, the helium bath and the low temperature reservoir. In the work reported in this paper the material for the working substance has been ferric alum and the thermal valves have been constructed from superconducting lead wires. A discussion is given of the requirements for an ideal working substance and experimental results are reported on some unusual paramagnetic materials which have been investigated for use both as working substances and for reservoir materials. Amongst these ferric acetylacetonate and synthetic ruby have been found to show useful properties. Finally, some of the possible uses of the magnetic refrigerator are considered, as for example in calorimetry below 1°K, for the establishment of an isothermal reservoir for the initiation of single-stage magnetic cooling, for the production of liquid helium baths below 1°K and for the possible subsequent extension of the magnetic refrigerator to a two-stage device for the production of isothermal temperatures well below 0.1°K. A.

536.5.081 : 536.42

7066. THE TRIPLE POINT OF CARBON DIOXIDE AS A THERMOMETRIC FIXED POINT. D.Ambrose.
Brit. J. appl. Phys., Vol. 8, No. 1, 32-4 (Jan., 1957).

In the technique described, a cell provided with a thermometer pocket was filled with purified carbon dioxide and cooled in a stirred-liquid bath to −56.6°C. The three-phase equilibrium was then established and the temperature of a thermometer inserted in the cell remained constant, provided that the temperature of the bath was maintained at −56.6 ± 0.5°C. The value found for the triple-point temperature was −56.603°C with a reproducibility of ± 0.002°C.

A.

536.511

7067. HIGH TEMPERATURE MEASUREMENTS WITH A GAS THERMOMETER. I. A NEW GAS THERMOMETER METHOD.
H.Moser, J.Otto and W.Thomas.
Z. Phys., Vol. 147, No. 1, 59-75 (1957). In German.

In the past the constant pressure or constant volume technique has been used with the gas thermometer. It is claimed that these are not really satisfactory for high temperature work and a new "constant temperature" method is described. The uncontrollable desorption effect is eliminated and other errors are reduced. The theory of the method is given together with a detailed description of the apparatus. A highly accurate differential manometer has been designed to permit accurate control and measurement of the gas pressure. A number of corrections are considered in detail and an accuracy of 0.1°C is claimed at the gold point. E.H.Dock

536.511

7068. HIGH TEMPERATURE MEASUREMENTS WITH A GAS THERMOMETER. II. DETERMINATION OF THE GOLD POINT.
H.Moser, J.Otto and W.Thomas.
Z. Phys., Vol. 147, No. 1, 76-91 (1957). In German.

The best estimate of the gold point, from published work, is considered to be 1063.7°C. The particular arrangement of the gas thermometer, described in Pt I (see preceding abstract), is illustrated and described. The gas vessel, double-walled and made of quartz, is enclosed in an outer tube and the intervening space is filled with gold. Heating is carried out by inserting the vessel into a suitable electric furnace. Full details of the apparatus and the method are given and a final figure of 1064.76°±0.1°C is quoted. This is a mean value at zero pressure extrapolated from results with $N_2$, A, $CO_2$, Kr, and Xe. The total variation over the five gases before reducing to zero pressure was 0.28°C (there were thirty determinations of the freezing point and thirty two of the melting point). E.H.Dock

536.63 : 536.48

7069. THE SPECIFIC HEAT FUNCTION FOR A TWO-DIMENSIONAL CONTINUUM. M.Dank and S.W.Barber.
Math. Tables Aids Comput., Vol. 9, 191-4 (Oct., 1955).

A table of numerical values of f(x) is given over the range 0.6(0.1)9.5 and 10.0(0.5)16.0, where

$$f(x) = \frac{6}{x^3}\int_0^x \frac{u^3 du}{e^u - 1} - \frac{2x}{e^x - 1}$$

The function appears in the theory of low-temperature specific heats of two dimensional structures (V.V.Sarasov, Zh. fiz. Khim., Vol. 24, 111-28, 1950). L.S.Goddard

536.631

7070. HEAT CAPACITY OF ORDERED $Mg_3Cd$ BETWEEN 4 AND 15°K. U.M.Bergenlid, R.S.Craig and W.E.Wallace.
J. Amer. Chem. Soc., Vol. 79, No. 8, 2019-20 (April 20, 1957).

Reports results of low temperature specific heat measurements and deduces an approximate value of the electronic heat coefficient ($0.8 \times 10^{-3}$ joule $mol^{-1}$ $deg^{-2}$) and of the Debye temperature, which has a minimum value 226°K at 18°K and approaches 292°K at 0°K. The results are compared with those for Mg and Cd. E.P.Wohlfarth

536.652

7071. MEASUREMENT OF THE HEAT CAPACITY OF SILICON BETWEEN 1200° AND 1550°C. M.Olette.
C.R. Acad. Sci. (Paris), Vol. 244, No. 8, 1033-6 (Feb. 18, 1957). In French.

Reports results of measurements of the enthalpy of 99.99% pure Si using the apparatus described in Abstr. 6130 (1957). The melting point is 1412 ± 2°C and the latent heat of fusion 12.095 ± 0.100 kcal $mol^{-1}$. E.P.Wohlfarth

536.653 : 541.64

7072. ENTROPY OF MIXING OF DILUTE POLYMER SOLUTIONS. A.H.Emery,Jr.
J. chem. Phys., Vol. 26, No. 5, 1254-8 (May, 1957).

The entropy of mixing of dilute solutions of high polymers has been calculated. The expression obtained employs a molecular dimension obtained from the intrinsic viscocity, contains no arbitrary constants, and appears to be valid from zero to about 2% polymer, the limit of the osmotic pressure data used. A.

536.662.08

7073. A METHOD FOR THE MEASUREMENT OF HEAT GENERATION IN POWDERED COAL. P.C.Newman.
Brit. J. appl. Phys., Vol. 8, No. 4, 162-7 (April, 1957).

A new method is proposed for measuring the generation of heat in coal or other finely divided powders. This method depends only on the thermal constants of the material and not on the heat losses to the surroundings of the calorimeter. New solutions to the heat flow equation for heat generation in cylindrical and spherical bodies as required for calculating the results are presented, and experimental confirmation of the suitability of the method is obtained. During the course of the work, an interesting result is obtained on the critical sizes of systems which generate heat at a rate which increases linearly with temperature. A.

# THERMODYNAMICS 536.7/.8

536.7

7074. ON THE GENERAL VALIDITY OF THE GIBERT—ONSAGER RECIPROCAL RELATIONS. M.Dodé.
C.R. Acad. Sci. (Paris), Vol. 243, No. 13, 888-91 (Sept. 24, 1956). In French.

The author takes seriously Gibert's attempt (Abstr. 7645/1953) to deduce the reciprocity relations from the alleged existence of an entropy-creation function. He claims to improve the argument and to show that Gibert's relations are completely general. R.O.Davies

536.7 : 539.371

7075. THERMODYNAMICS FOR ELASTIC SOLIDS. GENERAL FORMULATION. T.-W.Ting and J.C.M.Li.
Phys. Rev., Vol. 106, No. 6, 1165-[illegible] 15, 1957).

A condensed collection of all the thermodynamic formulae involving first derivatives for elastic solids under the outside variations of only temperature and stress is presented. The application is illustrated with some examples. A.

536.7

7076. FOUNDATIONS OF THERMODYNAMICS. P.T.Landsberg.
Rev. mod. Phys., Vol. 28, No. 4, 363-92 (Oct., 1956).

The purpose of this paper is to effect a geometrization of thermodynamics by a further development of the axiomatic approach initiated by Carathéodory, and developed by Born. The paper deals throughout with sets of points in a suitably defined n-dimensional thermodynamic phase space E. For properly restricted ranges of the independent variables of a given system, there will exist a set of points $\beta$ with the following properties: for any two points A, B of $\beta$, there exists an adiabatic linkage between the states which these points represent. The first law of thermodynamics is concerned largely with such sets of points $\beta$. The second law deals with subsets $\gamma$ of $\beta$ which fill an n-dimensional volume in E, and it is essential that these subsets be open (i.e. they must exclude boundary points). At this stage questions like whether a set $\beta$ can contain boundary points of any of its subsets $\gamma$ are still unanswered. A third law becomes therefore absolutely essential if ambiguities are to be avoided. Thus, as a result of this geometrization of thermodynamics, the third law appears in a novel form. The main results have been formulated in 10, 10 and 3 theorems, which relate respectively to the three laws of thermodynamics. There are 6 assumptions and 15 definitions. Most of the material presented appears at least in a new form; those parts of the subject which are covered adequately elsewhere have been omitted. H.London

# ELECTRICITY 537

# ELECTROSTATICS. DIELECTRICS 537.2

537.221

7077. CONTACT ELECTRIFICATION ACROSS METAL—DIELECTRIC AND DIELECTRIC—DIELECTRIC INTERFACES. G.S.Rose and S.G.Ward.
Brit. J. appl. Phys., Vol. 8, No. 3, 121-6 (March, 1957).

An apparatus is described by means of which a spherical dielectric surface can be compressed under various loads against either a plane metal disk or a plane dielectric disk. A transfer of electric charge across the interface is recorded when the surfaces are separated. The polarity of charging between any two materials depends upon the relative positions of those materials in an electrostatic series; a metal surface does not always assume a positive charge as found for impact electrification. For two given materials the amount of charge is proportional to the contact area between the surfaces and provided that one of the surfaces has a resistivity above a critical value ($5 \times 10^{11}$ Ω cm) then the charge density for various combinations of materials is approximately proportional to the lower dielectric constant in each combination. This result suggests that the charging may be limited by electrical back-discharge between the separating surfaces. It is considered to be unlikely that the electrification originates from a difference in the contact potentials of the two surfaces involved. A.

537.221 : 537.533.2

7078. CONTACT POTENTIAL DIFFERENCE MEASUREMENTS BY THE KELVIN METHOD. J.C.Rivière.
Proc. Phys. Soc. B, Vol. 70, Pt 7, 676-86 (July, 1957).

Measurements of contact potential differences between clean metallic surfaces produced by condensation from the vapour, by the vibrating condenser modification of the Kelvin method, yield the following values for average work functions, on the basis of an assumed value of 4.565 ± 0.025 eV for the work function of tungsten: copper, 4.52 ± 0.04 eV; silver, 4.31 ± 0.03 eV; gold, 4.70 ± 0.03 eV; aluminium, 4.20 ± 0.05 eV; nickel, 4.74 ± 0.04 eV; molybdenum, 4.22 ± 0.05 eV; iron, 4.17 ± 0.03 eV. The lack of contamination and the reproducibility of results are attributed to the use of molybdenum gettering films, and to the outgassing procedures employed. A.

537.226 : 537.311.33

7079. EXPERIMENTAL STUDY OF ELECTRICAL CONDUCTIVITY AND POLARIZATION IN LITHIUM FLUORIDE. H.Curien and Z.Mihailovic.
Bull. Soc. Franç. Minéral. Crist., Vol. 80, No. 1-3, 84-9 (Jan.-March, 1957). In French.

An account of preliminary work, indicating that the electrical properties of single-crystal specimens may largely be determined by dislocations. C.Hilsum

537.226.1

7080. DIELECTRIC ELLIPSOIDS AND SURFACES OF DIELECTRIC PERMITTIVITY. I.S.Zheludev.
Kristallografiya, Vol. 1, No. 1, 105-11 (1956). In Russian.

The dielectric permittivity tensor (Fresnel ellipsoid) and its inverse (index ellipsoid) are interpreted geometrically. A simple graphical method is described for obtaining two of the vectors of displacement, field or polarization given the other one in an anisotropic medium. The analogy with the optical case, involving refractive index is also discussed. R.F.S.Hearmon

537.226.2

7081. THEORY OF HYSTERESIS PHENOMENA IN BARIUM TITANATE. L.P.Kholodenko.
Kristallografiya, Vol. 1, No. 4, 393-402 (1956). In Russian.

A theoretical treatment of the dependence of polarization on field intensity above and below the transition point. An explanation is given of double hysteresis loops (Abstr. 7654/1953).

R.F.S.Hearmon

537.226.2 : 621.315.614.64 : 621.315.616.9

7082. TEMPERATURE COEFFICIENT OF RESISTIVITY OF POLYTHENE AND OIL-IMPREGNATED PAPER.
A.W.Stannett and D.H.Schroff.
Nature (London), Vol. 179, 94 (Jan. 12, 1957).

This has been measured between 40° and 80°C to make possible a calculation of the d.c. stress distribution in cable dielectric when a temperature gradient exists in the cable. The measurements were made on polythene, "non-draining" compound and oil-rosin impregnated cables. K.W.Plessner

537.226.2

7083. VARIATION WITH PRESSURE OF THE PERMITTIVITY OF POLYTHENE. A.C.Lynch and P.L.Parsons.
Nature (London), Vol. 179, 686 (March 30, 1957).

One electrode was smaller than the disk, so that most of the stray capacitance was through polythene subject to the same pressure. The measured variation of capacity C with pressure P is $dC/CdP = 12.2 \times 10^{-6}$ cm²/kg, caused mainly by the compression of the material. The small remaining effect is interpreted as a change of polarizability $\alpha$ with pressure. Taking the compressibility as $31 \times 10^{-6}$ cm²/kg and the permittivity as 2.29, calculation gives an approximate value for $d\alpha/\alpha dP$ of $-3 \times 10^{-6}$ cm²/kg, somewhat less than that given by Reitzel (Abstr. 3233/1957).

R.C.Kell

537.226.32

7084. INVESTIGATION OF THE HETEROCHARGES OF ELECTRETS IN CARNAUBA WAX. A.I.Froĭman and V.M.Fridkin.
Kristallografiya, Vol. 1, No. 3, 342-50 (1956). In Russian.

The dependence of the heterocharges on field intensity and polarization temperature is investigated by measuring the discharge current when the wax is heated to a temperature below its melting point. The production of heterocharges follows an activation law, with an activation energy of 18 500 cal/mol. R.F.S.Hearmon

537.226.32 : 537.312.5

7085. SOME RESULTS OF INVESTIGATING THE PHOTOELECTRET STATE OF SINGLE SULPHUR CRYSTALS. V.M.Fridkin.
Kristallografiya, Vol. 1, No. 5, 557-63 (1956). In Russian.

Experimental data are given for the dependence of photoelectret charges on intensity and length of illumination. The duration of the residual polarization is also discussed (see also Abstr. 5085/1955).

R.F.S.Hearmon

537.226.32 : 537.312.5

7086. THE DEPOLARIZATION OF PHOTOPOLARIZED MONOCRYSTALS OF SULPHUR AT DIFFERENT TEMPERATURES. V.M.Fridkin.
Kristallografiya, Vol. 1, No. 6, 692-5 (1956). In Russian.

Continuing earlier work on electrets and photoelectrets (see two preceding abstracts), the depolarizing current was measured as the specimen was heated from −100 to +20°C. The measuring apparatus is described and the thermophotoelectret state of the specimen discussed. R.F.S.Hearmon

537.228.1

7087. PIEZOELECTRIC EFFECT IN Se.
H.Gobrecht, H.Hamisch and A.Tausend.
Z. Phys., Vol. 148, No. 2, 209-17 (1957). In German.

Experiments on the influence of ultrasonic waves on the electrical conductivity of Se showed that the hexagonal modification exhibits strong piezoelectric properties. The piezoelectric constant in the x-direction was $d_{11} = 1.95 \times 10^{-6} \pm 12\%$. H.J.H.Starks

# ELECTRIC CONDUCTION. CURRENTS 537.3

537.311.1

7088. THE g VALUE IN CONDUCTION ELECTRON SPIN RESONANCE. Y.Yafet.
Phys. Rev., Vol. 106, No. 4, 679-84 (May 15, 1957).

The departure of the g-factor from the free-spin value due to spin—orbit interaction is calculated for conduction electrons in a nondegenerate band. The Kohn—Luttinger representation is used and the result is obtained to second order in the wave-vector of the electron at the Fermi surface. The result is expressed in two forms, one of these being a sum of volume and surface integrals over the unit cell. The orders of magnitude of these are discussed but no numerical calculations are made. A.

537.311.31 : 539.234

7089. HIGHLY-CONDUCTING GOLD FILMS PREPARED BY VACUUM EVAPORATION. A.E.Ennos.
Brit. J. appl. Phys., Vol. 8, No. 3, 113-17 (March, 1957).

Thin gold films formed by vacuum evaporation on to freshly evaporated layers of certain metallic oxides show high conductivity, in a similar way to layers prepared by cathodic sputtering. The evaporated layers are robust and of high current-carrying capacity down to 30 A thickness. The conductivity approaches the bulk value for annealed films thicker than 60 A. The properties of these films are discussed in relation to those of the sputtered layers, with which they compare favourably. A.

537.311.31 : 539.234

7090. INFLUENCE OF THE SUPPORT ON THE ELECTRICAL CONDUCTIVITY OF VERY THIN FILMS OF GOLD. MEASUREMENT OF THE CONDENSATION FACTOR.
S.S.Minn and S.Offret.
C.R. Acad. Sci. (Paris), Vol. 244, No. 12, 1624-6 (March 18, 1957). In French.

The electrical conductivity of very thin films of gold is very dependent on the nature of the film support. Measurements were made to find if this effect is due to differences in the condensation factor in the first stage of evaporation of gold on supports of bismuth oxide, magnesium fluoride and glass. The results show however that the condensation factor is constant irrespective of film thickness or the nature of the support. It is suggested that the difference in conductivity may be due to differences in the mobility of the gold on the supports. R.C.Glass

537.311.31 : 538.632

7091. MEASUREMENTS OF THE HALL EFFECT AND CONDUCTIVITY IN THIN POTASSIUM FILMS. W.Cirkler.
Z. Phys., Vol. 147, No. 4, 481-98 (1957). In German.

Films with measured thickness d varying from 30 to 2000 A were produced in a uniform magnetic field and very high vacuum by condensation on a surface at 90°K. Graphs showing the variations with d of the Hall coefficient $R_H$ and the conductivity are compared with Sondheimer's theoretical curves (Abstr. 3578/1952). Agreement is obtained for $d > 450$ A by taking the surface scattering parameter as 0.5. As d decreases between 450 and 50 A, $R_H$ rises from its constant bulk value of $R_H \times 10^5 = 42.3 \pm 1.3$ cm³ amp⁻¹ sec⁻¹ though less steeply than the theoretical curve. D.M.Edwards

537.311.31 : 548.7

RESISTIVITY OF QUENCHED ALUMINIUM. See Abstr. 6716

537.311.33

7092. SEMICONDUCTOR SURFACE PHYSICS.
Edited by R.H.Kingston, with the assistance of E.Burstein, A.L.McWhorter, P.H.Miller, Jr, D.T.Stevenson and P.B.Weisz.
Philadelphia: University of Pennsylvania Press (1957) xvi + 413 pp.

Proceedings of a Conference held at the University of Pennsylvania, June 4-6, 1956, sponsored by the University, by the Office of Naval Research, and by the Lincoln Laboratory of M.I.T. The proceedings are divided into four sections: I. Clean surfaces. II. Real surfaces. III. Adsorption and catalysis. IV. Oxidation. Abstracts of some of the papers will be published later.

537.311.33

7093. A SIMPLE GRAPHICAL METHOD OF CALCULATING THE DENSITY OF CURRENT CARRIERS IN A SEMI-CONDUCTOR FROM THE HALL COEFFICIENT. T.S.Robinson, M.Smollet and R.G.Pratt.
Brit. J. appl. Phys., Vol. 8, No. 3, 130-1 (March, 1957).

A simple analysis leads to curves from which the hole and electron concentrations may be separately determined, provided that the mobility ratio and the intrinsic carrier density, are known, and that the Hall coefficient at one temperature is measured.

C.A.Hogarth

537.311.33 : 535.39

7094. DETERMINATION OF OPTICAL CONSTANTS AND CARRIER EFFECTIVE MASS OF SEMICONDUCTORS.
W.G.Spitzer and H.Y.Fan.
Phys. Rev., Vol. 106, No. 5, 882-90 (June 1, 1957).

By using reflectivity and absorption measurements in the region 5 to 35 microns, the effect of free carriers on the optical constants has been determined for n- and p-type germanium, silicon, and indium antimonide, and for n-type indium arsenide. The contribution of the free carriers to the electric susceptibility is obtained from the optical constants. A carrier effective mass, $m_S$, is defined in terms of the susceptibility, and the significance of $m_S$ is considered for four different types of energy band structure. The experimental values of $m_S$ are compared with those calculated by using data from other experiments. Good agreement was found for n- and p-type silicon, n-type germanium, and p-type indium antimonide. In p-type germanium, the susceptibility due to transitions between the overlapping bands in the valence band was taken into account. However, the resulting $m_S$, for a sample of $\sim 10^{18}$ cm$^{-3}$ impurity concentration, is larger by a factor of 1.8 than that calculated by using cyclotron resonance data. In n-type indium antimonide $m_S$ increases with carrier concentration. If one assumes $m_S$ to be energy-dependent, the shape of the conduction band calculated is consistent with previously reported measurements of the shift of the intrinsic absorption edge with electron concentrations. In the case of n-type indium arsenide, $m_S$ differs from the effective mass reported from thermoelectric measurements but gives good agreement with the values determined from the shift of the intrinsic absorption edge for an impure specimen. A.

537.311.33

7095. EXPERIMENTAL DETERMINATION OF INJECTED CARRIER RECOMBINATION RATES AT DISLOCATIONS IN SEMICONDUCTORS. J.P.McKelvey.
Phys. Rev., Vol. 106, No. 5, 910-17 (June 1, 1957).

The recombination probabilities associated with lineage boundaries in germanium have been determined by measuring the ratio of injected carrier concentrations on either side of such a boundary. If one knows the linear density of dislocations in the lineage boundary, the recombination cross-section for a single dislocation can be inferred. The measured cross-sections correspond to cylindrical recombination areas of diameter 1.15 A for holes in n-type germanium and 2.8 A for electrons in p-type germanium. On the basis of recombination at dislocations alone, these results can be used to compute the expected lifetime as a function of dislocation density, and it is concluded from these calculations that a significant part of carrier recombination in the usual melt-grown crystals takes place at dislocations. A.

537.311.33

7096. SOME CONTRIBUTIONS TO THE THEORY OF ELECTRICAL CONDUCTIVITY, THERMAL CONDUCTIVITY AND THERMOELECTRIC POWER IN SEMICONDUCTORS. J.E.Parrott.
Proc. Phys. Soc. B, Vol. 70, Pt 6, 590-607 (June, 1957).

The theory of transport phenomena in semiconductors is extended to include the effects of "phonon drag" on electrons and "electron drag" on phonons. A simple phenomenological theory is developed first, and it is shown that this gives a good semi-quantitative account of the effects under investigation. Commencing with the Boltzmann equation for electrons and phonons, the electrical conductivity, the thermal conductivity and the thermoelectric coefficients are calculated exactly, under certain simplifying assumptions. Where possible, the theoretical results are compared with experimental data and it is shown that general, though not exact, agreement prevails. A.

537.311.33

7097. MEASUREMENT OF CARRIER RECOMBINATION VELOCITY BY CONDUCTIVITY MODULATION.
K.D.Glinchuk, E.G.Miselyuk and É.I.Rashba.
Zh. tekh. Fiz., Vol. 26, No. 12, 2607-13 (1956). In Russian.

The photoelectric ("travelling light spot") method of diffusion length measurement is unsuitable for very short lifetime material. An alternative method is presented. Equations for the conductivity modulation produced in a semiconductor by illumination are derived in terms of surface and body recombination. Experimental details of the method of determining lifetime $\tau$ and surface recombination velocity s are given. The method is particularly suited to the measurement of large s (say $10^4$ to $10^5$cm sec$^{-1}$) and small $\tau$ ($< 1\,\mu$sec). J.B.Arthur

537.311.33

7098. ELECTRICAL AND OPTICAL PROPERTIES OF ALUMINIUM ANTIMONIDE; EFFECT OF LITHIUM.
F.Kover and A.Quilliet.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1739-41 (March 25, 1957). In French.

Measurements of resistivity, Hall coefficient, and photoconductivity on crystals containing increasing amounts of lithium as doping agent are reported. Increasing amounts of Li increase the resistivity and apparent purity by filling vacant antimony sites. C.A.Hogarth

537.311.33 : 538.632

7099. THE HALL EFFECT IN THIN FILMS OF BISMUTH.
A.Colombani and P.Huet.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1344-7 (March 4, 1957). In French.

Preliminary results on thin films of thickness from 60 to 6000 A which had been heat treated to render the d.c. electrical properties stable. The Hall coefficient was found to vary with the magnetic field particularly at the larger values (up to 34 000 oersted) used. C.A.Hogarth

537.311.33 : 538.63

7100. MAGNETORESISTANCE IN THIN FILMS OF BISMUTH.
P.Huet and A.Colombani.
C.R. Acad. Sci. (Paris), Vol. 244, 1626-9 (March 18, 1957). In French.

Results are given for the transverse magnetoresistance in the plane of the film for magnetic fields up to 35 000 Oe and for film thicknesses between 25 and 2800 A, all the films having a ratio of length to width of 0.1. The magnetoresistance was always positive, and above ~15 000 Oe could be represented by the relation $\Delta R/R = kH^{3/2}$ in which k varied linearly for thicknesses less than 200 A but was independent of thicknesses greater than 1500 A. These results are said to be consistent with previous determinations of the Hall coefficient and conductivity. There is no theoretical discussion. D.J.Oliver

537.311.33 : 538.63

7101. MAGNETORESISTANCE OF A P-TYPE SEMICONDUCTING DIAMOND. E.W.J.Mitchell and P.T.Wedepohl.
Proc. Phys. Soc. B, Vol. 70, Pt 5, 527-30 (May, 1957).

The magnetoresistance $\Delta r/r$ was measured as a function of field strength H up to about 4000 Oe, and of angle $\theta$ between current I and H. The transverse $\Delta r/r$ was reasonably linear with $H^2$. A plot of $\Delta r/rH^2$ as a function of $\theta$ was fitted to a theoretical expression for semiconductors due to Seitz and found to depend little on orientation of I and H relative to the crystallographic axes. The longitudinal $\Delta r/r$ was smaller than the transverse value for all directions, these two features agreeing with results known for p-type Ge and Si. D.Haneman

537.311.33 : 548.736.4

7102. A NEW GROUP OF COMPOUNDS WITH DIAMOND-TYPE (CHALCOPYRITE) STRUCTURE. C.H.L.Goodman.
Nature (London), Vol. 179, 828-9 (April 20, 1957).

A II-IV-$V_2$ series of compounds derived from the III-V zinc blende series is described. The seven members so far found are phosphides or arsenides; antimonides and bismuthides do not appear to form. It is suggested that in these compounds energy gap (E) is largely determined by the relatively weak IV-V bonds. Optical E values are given for $CdGeP_2$, $ZnGeP_2$, $ZnSiAs_2$ and $ZnGeAs_2$ (1.8, 2.0-2.4, 2.1 and $> 0.6$ eV, respectively). It is briefly noted that nominal compositions $CdSnP_2$ and $ZnSnP_2$ did not form diamond-type structures; they appeared to be semiconductors with E = 1.5 and 2.1 eV, respectively. C.H.L.Goodman

537.311.33 : 538.61

7103. EXPERIMENTS ON THE PHOTOMAGNETOELECTRIC EFFECT IN GERMANIUM. T.M.Buck and F.S.McKim.
Phys. Rev., Vol. 106, No. 5, 904-9 (June 1, 1957).

The photomagnetoelectric (PME) effect in germanium has been investigated over a wide range of light intensity, in both n- and p-type material. Measurements of PME short-circuit current in conjunction with relative conductance increase agree well with van Roosbroeck's recently developed theory of the PME effect (Abstr. 3720/1956). The predicted large-signal behaviour of ambipolar excess-carrier diffusivity is verified. Surface recombination velocities for different surface treatments have been determined with slabs of thicknesses appreciably smaller than a diffusion length. Volume lifetimes have been determined with thicker slabs having

high-recombination-velocity dark surfaces. These lifetimes are in substantial agreement with those determined for the same samples by the photoconductivity-decay method. A.

537.311.33 : 538.63

7104. THE MAGNETORESISTANCE OF THE NICKEL-ZINC FERRITE SYSTEM. R.Parker.
Proc. Phys. Soc. B, Vol. 70, Pt 5, 531-3 (May, 1957).

Specimens were in the composition range $Ni_{(1-x)}Zn_xFe_2O_4$, with x varying from 0 to 0.8, and had room temperature resistivities of about $10^8$ ohm cm, all being p-type semiconductors. No discontinuity in the resistivity temperature curve at the Curie point was found. The magnetoresistance $\Delta\rho/\rho$ was negative and decreased with increasing magnetization until technical saturation, whereafter no further changes were observed. The above features are in contrast to those for ferromagnetic materials. The saturation $\Delta\rho/\rho$ fell rapidly with temperature, being extremely small above 350° C. The observations impose difficulties on theoretical models for magnetoresistance. D.Haneman

537.311.33

7105. TRANSIT TIME MEASUREMENTS OF CHARGE CARRIERS IN AMORPHOUS SELENIUM FILMS. W.E.Spear.
Proc. Phys. Soc. B, Vol. 70, Pt 7, 669-75 (July, 1957).

A technique similar to that used in crystal counter experiments is applied to the study of transit times of electrons and holes in thin evaporated films of amorphous Se carrying Au electrodes. Electron-hole pairs are generated near the top electrode by short electron pulses (or light flashes) of $10^{-7}$ sec duration. The pulses observed when electrons are drawn across the specimen show a perfectly linear rising edge. The measured transit times lead to consistent effective mobility values $\mu_-$, between 4.7 and 5.5 x $10^{-3}$ $cm^2 sec^{-1} v^{-1}$ For holes, $\mu_+ \cong 0.15$ $cm^2 sec^{-1} v^{-1}$. The measurements are a direct confirmation of deductions made from previous experiments. An investigation of the temperature dependence of mobility shows that $\mu_-$ is predominantly controlled by thermal release from trapping states lying at a depth of 0.25 eV below the conduction band; for holes the corresponding energy is about 0.16 eV. The observed discharge effects indicate the presence of a range of deeper trapping states. Their effect on the field is normally negligible, but they are likely to act as recombination centres. Recombination processes play an important part in the region of excitation; they cannot be described by a bi-molecular model. A.

537.311.33

7106. ELECTRICAL CONDUCTIVITY IN SILVER HALIDE SINGLE CRYSTALS. R.Matejec.
Naturwissenschaften, Vol. 43, No. 23, 533-4 (1956). In German.

From the conductivity–reciprocal-temperature curve, evidence is obtained for an irreversible decrease of interstitial silver and an increase of silver ion vacancies during exposure at 20° C. This only occurs when traces of sulphide impurity are present. The significance of these results in relation to the latent image is discussed. J.E.Caffyn

537.311.33

7107. ON THE INFLUENCE OF HYDROGEN ON THE ELECTRICAL CONDUCTIVITY AT THE SURFACE OF ZINC OXIDE CRYSTALS. G.Heiland.
Z. Phys., Vol. 148, No. 1, 15-27 (1957). In German.

Surface layers, with a constant conductivity in the temperature range 60 to 200° K, were formed in a few seconds, by the action of atomic hydrogen at temperatures down to 86° K. They could be removed by heating in vacuum, at 500-600° K, or by the absorption of oxygen, and were only restored by renewed action with atomic hydrogen, thus providing a sensitive detector for the latter. The surface distribution of donor states is shown to be in excess of $6 \times 10^{12}$ $cm^{-2}$. The interpretation of the conductivity measurements is based on a surface accumulation layer with a strongly degenerate electron gas (see abstract following) as well as direct electron interchange between surface states. Very stable surface layers were produced by heating in molecular hydrogen at high temperatures (800° K). These could also be removed by heating in oxygen but were restorable by desorption of the oxygen. It is suggested that the surface donors may be due to excess zinc. R.Stratton

537.311.33

7108. THEORY OF THE ACCUMULATION LAYER AT THE SURFACE OF SEMICONDUCTORS. G.Heiland.
Z. Phys., Vol. 148, No. 1, 28-33 (1957). In German.

The increase in free charge carrier density near the surface, caused by ionized surface states, is derived for strongly degenerate and classical statistics. The results are applied to surface conductance measurements on zinc oxide crystals (see preceding abstract). R.Stratton

537.311.33 : 537.323 : 536.21

THERMAL CONDUCTIVITY AND THERMOELECTRIC POWER OF SEMICONDUCTORS. See Abstr. 7047

537.311.33 : 537.226

EXPERIMENTAL STUDY OF ELECTRICAL CONDUCTIVITY AND POLARIZATION IN LITHIUM FLUORIDE. See Abstr. 7079

537.311.33 : 621.314.7

7109. MEASUREMENTS ON ALLOY-TYPE TRANSISTORS WITH VARYING COLLECTOR VOLTAGE. D.M.Evans.
Brit. J. appl. Phys., Vol. 8, No. 1, 44-5 (Jan., 1957).

Parameters in the theoretical expression for the frequency cut-off $f_c$ of a normally biased junction transistor were separately determined for two commercial p–n–p alloy transistors confirming the linear relation between base width and half-power of collector voltage $V_c$. Theoretical and experimental values of $f_c$ at various $V_c$ were in fair agreement. D.Haneman

537.311.33 : 621.314.63

7110. A MILLISECOND RELAXATION PROCESS IN THE REVERSE CURRENT OF GERMANIUM POINT-CONTACT DIODES. R.E.Burgess.
Brit. J. appl. Phys., Vol. 8, No. 2, 62-3 (Feb., 1957).

When a reverse voltage is suddenly applied to a germanium point-contact diode initially having zero bias it has been found that there is usually a decrease of current to the final steady value with a relaxation time of about 1 msec. Possible mechanisms for this process are discussed, and it is suggested that redistribution of surface charge is the most likely cause. A.

537.311.33

7111. ON THE CURRENT–VOLTAGE CHARACTERISTICS OF RECTIFYING METAL–GERMANIUM CONTACTS. G.Mesnard and A.Dolce.
C.R. Acad. Sci. (Paris), Vol. 244, No. 15, 2025-8 (April 8, 1957). In French.

A theoretical expression giving the general shape of experimental curves is obtained by considering electron and hole currents in the barrier region, without recourse to special mechanisms. D.Haneman

537.311.33

7112. THE VARIATION OF THE REVERSE CURRENT OF RECTIFYING METAL–GERMANIUM CONTACTS WHEN THE CONCENTRATIONS OF CARRIERS IN THE SEMICONDUCTOR INTERIOR DEPART FROM THEIR THERMAL EQUILIBRIUM VALUES. G.Mesnard and A.Dolce.
C.R. Acad. Sci. (Paris), Vol. 244, No. 16, 2141-3 (April 15, 1957) In French.

Expressions for the electron and hole currents for these conditions are derived and discussed. D.Haneman

537.311.33 : 621.314.63

7113. EFFECTS OF IRRADIATION UPON DIODES OF THE SILICON JUNCTION TYPE. R.Gorton.
Nature (London), Vol. 179, 864 (April 27, 1957).

Irradiation over a range from $0.75 \times 10^{14}$ to $8 \times 10^{14}$ neutrons/$cm^2$ led to a reduction of the minority carrier storage effect which caused a progressive change in the forward characteristic. R.Stratton

537.311.62 : 621.3.014.12

7114. THE SKIN EFFECT IN AN ARRAY OF CONDUCTORS OF RECTANGULAR CROSS-SECTION. L.A.Tseĭtlin.
Zh. tekh. Fiz., Vol. 26, No. 12, 2771-7 (1956). In Russian.

The problem of skin and proximity effects was solved theoretically by J.D.Cockcroft (Proc. Roy. Soc., Vol. 122, 533-42, Feb. 4, 1929) for one and two conductors and by G.V.Der-Shvarts (Zh. tekh. Fiz., Vol. 18, 1405, 1948) for an array of conductors of any dimensions. The last solution involves some non-tabulated functions with parameters related in an involved way with geometrical dimensions of the array. The author discusses the problem of thin conductors of semi-infinite length which permits of an analytical solution and compares it with the one of conductors of finite length. It is shown that the treatment used for semi-infinite conductors produces results nearly identical to those derived for conductors of finite length. The same method is applied to conductors of finite thickness and after the evaluation of energy and current the formulae for $R/R_0$ and L are derived. M.W.Makowski

537.312.5

7115. ON THE CAPACITY OF SELENIUM PHOTOCELLS. M.Bichara.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 742-4 (Feb. 4, 1957). In French.

537.312.5

7116. ON THE EFFECT OF FLUCTUATIONS IN SELENIUM PHOTOVOLTAIC CELLS. M.Téboul and N.Nifontoff.
C.R. Acad. Sci. (Paris), Vol. 244, No. 12, 1631-3 (March 18, 1957). In French.

The noise level in Se photovoltaic cells depends on the polarizing voltage, and is independent of the incident light intensity, whether the cell is biased in a forward or reverse direction. J.Franks

537.312.5

7117. EFFECT OF TEMPERATURE ON THE HEIGHT OF THE POTENTIAL BARRIER IN SELENIUM PHOTOCELLS. G.Blet.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1754-6 (March 25, 1957). In French.

For a given illumination of Se photocells, the e.m.f. increases as the temperature drops. The potential-barrier height is independent of temperature between 125 and 300°K, the leakage resistance increases rapidly with decreasing temperature. J.Franks

537.312.5 : 541.183.26

7118. ZINC OXIDE PHOTOCONDUCTION, AN OXYGEN ADSORPTION PROCESS. D.A.Melnick.
J. chem. Phys., Vol. 26, No. 5, 1136-46 (May, 1957).

Photoconductive rise and decay curves of porous sintered zinc oxide are studied as a function of time (0.3 to $10^7$ sec), ambient oxygen pressure ($5 \times 10^{-5}$ to 760 mm), temperature (110° to 373°K), incident light intensity (factor of $10^3$), and various cycling procedures in regard to illumination. The photoconductivity is shown to be entirely due to the desorption of chemically adsorbed oxygen atoms from the surfaces of the porous sample. Light of wavelength near the fundamental absorption edge forms electron–hole pairs of which the hole is captured by the oxygen, converting the oxygen to physically adsorbed. The physically adsorbed oxygen easily desorbs and the electron remains to increase the conductivity. The kinetics of the adsorption process when the light is removed are found to obey the Elovich equation, $dq/dt = a \exp(-bq)$, where q is the density of adsorbate, and a and b are constants. It is believed that the limiting process is electron transfer through the Schottky barrier, since it results in an equation equivalent to the empirical one above. Experimentally a continuous spectrum of time constants is found. A technique has been developed for analysing experimental curves into component time constant processes. The Elovich equation results in time constants depending upon the intensity of illumination. The continuous spectrum of time constants can therefore be attributed to this variation of intensity with depth in the sample. A.

537.312.5

7119. PHOTOCONDUCTION IN KBr AND KI CONTAINING F CENTERS. N.Inchauspe.
Phys. Rev., Vol. 106, No. 5, 898-903 (June 1, 1957).

Photoconductivity in potassium bromide and potassium iodide containing F-centres has been investigated at 80°K. The product of the quantum yield and unit range has been measured over the spectral range from 2.0 to 5.8 eV with F-centre concentrations between $10^{15}$ and $10^{17}$ $cm^{-3}$. Evidence is presented that the mechanism for the production of photoelectrons depends upon the photon energy and the concentration of F-centres. Two mechanisms for the production of photoelectrons are suggested by the data: the ionization of F-centres by excitons and direct optical ionization of F-centres. A.

537.312.5

7120. TEMPERATURE DEPENDENCE OF THE SPECTRAL DISTRIBUTION OF PHOTOCONDUCTIVITY FOR GALLIUM SELENIDE AND TELLURIDE. S.M.Ryvkin and R.Yu.Khansevarov.
Zh. tekh. Fiz., Vol. 26, No. 12, 2781-3 (1956). In Russian.

Photoconductive response curves for GaSe and GaTe (of conductivity $10^{-4} - 10^{-3}$ $ohm^{-1}cm^{-1}$) were obtained for various temperatures. Room temperature energy gaps ($\lambda_{1/2}$ values) were 2.04 and 1.65 eV respectively, with temperature shifts of 2.3 and 2.4 A/deg. Some specimens showed a supplementary long-wave peak at low temperatures. C.H.L.Goodman

537.312.5

7121. THE OUTER PHOTOELECTRIC EFFECT OF THE ALKALI METALS. I. THE DEPENDENCE ON LAYER THICKNESS FOR POTASSIUM OF THE RANGE OF PHOTOELECTRONS IN THE METAL. H.Thomas.
Z. Phys., Vol. 147, No. 4, 395-418 (1957). In German.

The dependence of the photoelectric effect in potassium on the layer thickness is measured over the wavelength region 0.289 to 0.578 $\mu$. The photoelectron range is from 2 atom layers at 0.3 $\mu$ to 200 layers at 0.5 $\mu$ and is explained by the marked energy dependence of electron–electron interaction in the metal. G.F.J.Garlick

537.312.5

7122. THE OUTER PHOTOELECTRIC EFFECT OF THE ALKALI METALS. II. SPECTRAL DISTRIBUTION OF THE QUANTUM YIELD FOR POTASSIUM. H.Mayer and H.Thomas.
Z. Phys., Vol. 147, No. 4, 419-41 (1957). In German.

The photoelectric spectral response and optical absorption spectrum is determined for potassium layers when light is incident at 45° to the surface and plane polarized either with electric vector in the incidence plane or at right angles to it. With the light vector in the incidence plane and for thin films an absorption and photoelectron emission maximum occur at 0.35 $\mu$ but the quantum efficiency derived from each shows a steady rise with decreasing wavelength. Agreement is shown with the later theoretical derivations of the paper. Thick layers show a shift of the response maximum to longer wavelengths when the light vector is perpendicular to the incidence plane. G.F.J.Garlick

537.312.5

7123. THE OUTER PHOTOELECTRIC EFFECT OF THE ALKALI METALS. III. THE ENERGY DISTRIBUTION FOR POTASSIUM AND CAESIUM. S.Methfessel.
Z. Phys., Vol. 147, No. 4, 442-64 (1957). In German.

The energy distribution among the photoelectrons is determined at 90°K for ultraviolet light using a spherical retarding field. The distribution can be explained by a volume effect the electrons having a given range. For potassium agreement with theory is found over 8-40 atom thicknesses. For caesium strong electron interaction makes the distribution independent of layer thickness beyond a few atoms thick. G.F.J.Garlick

537.312.62 : 538.222

7124. PARAMAGNETIC EFFECT IN SUPERCONDUCTORS. IV. MEASUREMENTS ON ALUMINUM. A.H.Fitch and H.Meissner.
Phys. Rev., Vol., 106, No. 4, 733-6 (May 15, 1957).

For Pt III, see Abstr. 2895 (1956). A cryostat has been designed and constructed to permit investigation of superconductors having transition temperatures in the range from 1.4°K to below 0.9°K. By means of this cryostat, the paramagnetic effect, previously observed in In, Sn, Ta, Hg, Tl and NbN, has been observed at the superconducting transition of aluminium. The threshold current, $I_o$, required for the occurrence of the paramagnetic effect, had previously been shown to be related to the applied longitudinal field, $H_{zo}$, and the specimen diameter, d, by the equation $I_o = I_g + \gamma^* \pi H_{zo} d$, where $I_g$ and $\gamma^*$ are constants characteristic of a particular superconductor. Preliminary measurements on the six superconductors listed above had suggested that $I_g$ values occur only in multiples of 0.6 ampere. Measurements of $I_g$ for aluminium yield an $I_g$ value definitely less than 0.6 A. A.

537.312.62 : 536.71

7125. PHASE CHANGES OF THE SECOND ORDER. C.Hurst.
Proc. Phys. Soc. B, Vol. 70, Pt 6, 553-8 (June, 1957).

The ideal phase-transition in superconductors is analysed in such a way as to examine the connection between the two types of second-order phase change which are mathematically possible, viz. those associated with a finite length of transition line, and those confined to a singular point on a transition line which is elsewhere of first order. It is concluded (i) that the latter category of second-order transition appears only as a somewhat trivial case of the former, (ii) that it is very doubtful whether points of second-order equilibrium really exist in isolation. The discussion also shows how the superconducting phenomenon provides a good example of the existence of first-order transitions possessing volume discontinuities which are exceedingly small, but non-zero; this circumstance allows an Ehrenfest-type second-order phase change to be regarded as the limiting case of a first-order transition. A.

537.312.62 : 538.2

MAGNETIC PROPERTIES OF SOME SUPERCONDUCTING MERCURY COLLOIDS. See Abstr. 6337

537.312.62 : 536.212

THERMAL CONDUCTIVITY OF SUPERCONDUCTING MERCUR See Abstr. 7048

537.312.67

7126. ON THE CHANGES IN THE ELECTRICAL CONDUCTIVITY OF METALS UPON FUSION. G.Darmois.
C.R. Acad. Sci. (Paris), Vol. 244, No. 2, 174-6 (Jan. 7, 1957). In French.

The author proposes a modification of Sommerfeld's theory of conduction in metals which leads to values of the electronic free path of the order of the interatomic distance. E.H.Sondheimer

537.323 : 537.311.33 : 536.21

THERMOELECTRIC POWER OF SEMICONDUCTORS.
See Abstr. 7047

537.324 : 537.311.33

7127. SOLID SOLUTIONS OF $Bi_2Te_3$–$Bi_2Se_3$ AS A MATERIAL FOR THERMOELEMENTS. S.S.Sinani and G.N.Gordyakova.
Zh. tekh. Fiz., Vol. 26, No. 10, 2398-9 (1956). In Russian.

The results of an attempt to find an efficient semiconducting thermocouple element are reported briefly. A wide range of metallic elements, halogens and halides were added to a basic alloy of 80% $Bi_2Te_3$ – 20% $Bi_2Se_3$. Best results were obtained from AgI (0.1%), CuBr (0.05%), Ag (0.16%) and Cu (0.05%) which all gave similar figures of merit. J.B.Arthur

# ELECTRIC DISCHARGES 537.52

537.521

7128. DEVELOPMENT OF A GENERAL SOLUTION OF BOLTZMANN'S TRANSPORT EQUATION IN THE PRESENCE OF ELECTRIC AND MAGNETIC FIELDS. R.Jancel and T.Kahan.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1333-6 (March 4, 1957). In French.

The general solution is in terms of spherical harmonics and Fourier series. Boltzmann's integro-differential equation is solved for a plasma under the action of an oscillatory electric field and a constant magnetic field. L.S.Goddard

537.521.6 : 537.533 : 537.534

7129. PRE-BREAKDOWN CONDUCTION BETWEEN ELECTRODES IN CONTINUOUSLY-PUMPED VACUUM SYSTEMS. W.K.Mansfield and R.L.Fortescue.
Brit. J. appl. Phys., Vol. 8, No. 2, 73-8 (Feb., 1957).

Electron loading in electrostatic generator accelerator tubes due to the passage of pulses of current of millisecond duration has been investigated. The characteristics of pulse discharge conduction are described and a theory of its origin proposed. This theory envisages an exchange of positive and negative ions of hydrogen between the electrodes in a regenerative reaction, the source of the ions being a chemisorbed layer of hydrocarbon on the electrode surfaces. Measurements of the secondary emission coefficients and other experimental evidence appear to be consistent with such a hypothesis. Methods of suppression of this pulse discharge conduction are discussed. A.

537.523.4 : 621.316.933.1

7130. THE BREAKDOWN MECHANISM OF CERTAIN TRIGGERED SPARK GAPS. T.E.Broadbent.
Brit. J. appl. Phys., Vol. 8, No. 1, 37-40 (Jan., 1957).

Experiments designed to investigate the breakdown mechanism of certain triggered spark gaps in air are described. Possible theories of the breakdown mechanism of the trigatron and the thermally triggered spark gap are put forward, based on experimental voltage and time lag to breakdown characteristics, corona measurements, and on optical studies using a photomultiplier. It is shown that the mechanism of breakdown for the two forms of triggered spark gap may be similar and depend, with positive charging polarities, on the movement of positive ions followed by a streamer process, and, in case of negative charging polarities, on a streamer process only. A.

537.523.4

7131. THE DISAPPEARANCE OF $H^+$-IONS IN IONIZED HYDROGEN AT ATMOSPHERIC PRESSURE.
R.Herman, S.Weniger and L.Herman.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1179-82 (Feb. 25, 1957). In French.

Briefly describes the measurement of recombination coefficients (electron–ion process) using time-resolved spectroscopy of spark discharges in hydrogen. Numerical values for the coefficients are not given, but a graph of ion density v. time is shown. J.D.Craggs

537.523.4 : 534.222.2

7132. A STUDY OF SHOCK WAVES IN FLASH LAMPS. M.Cloupeau.
C.R. Acad. Sci. (Paris), Vol. 244, No. 15, 2033-6 (April 8, 1957). In French.

Describes the study of flash sources (condenser discharges) with a rotating mirror technique. Shock-wave effects were observed in the tubes, and photographs are given for xenon fillings. J.D.Craggs

537.523.5

7133. SHORT DURATION DISCHARGES BETWEEN SEPARATING CONTACTS IN A 6 V CIRCUIT. J.Riddlestone.
Brit. J. appl. Phys., Vol. 8, No. 3, 105-8 (March, 1957).

Records of arc voltages of very short duration between separating contacts have been obtained with an ultra-high-speed oscillograph. The contacts used were of platinum, palladium and silver. The closed circuit currents were 4.5 and 8 A for platinum and 4.5 A for palladium, the circuit inductance ranging from 0.07 to 4.7 $\mu$H. Representative records and a tabular analysis of their important characteristics are given. Discharges occur under all conditions covered in the experiments, their durations varying from about 0.01 to 1.0 $\mu$sec. Voltages are low, in some cases as low as 7 V, but usually lying within the range 10-18 V. It is shown that there is insufficient evidence as yet on which to base a theory of the arc at separation or a relationship between transfer and arc characteristics. A.

537.523.5

7134. ARC MOVEMENT AND ELECTRODE MAGNETISM. A.E.Guile, T.J.Lewis and S.F.Mehta.
Nature (London), Vol. 179, 1023-4 (May 18, 1957).

The cathode-spot velocity for arc currents of about 400 A, travelling between parallel mounted 1 cm dia. electrodes spaced at 3.2 cm, was found to increase uniformly with arc current and was much greater for magnetic than for non-magnetic electrode materials. Magnetization of the electrodes resulted in a helical movement of the cathode spot. By observation of the helical path with the type and direction of magnetization, it was concluded that the circumferential motion was determined by the axial magnetic field within the cathode surface. With no axial field present, the axial movement of the arc could similarly be associated with the circumferential field within the electrodes due to current flow. The importance of galvano- and thermomagnetic forces acting within the cathode and anode spots is pointed out. A.E.D.Heylen

537.525 : 537.562

7135. ON THE THEORY OF STATIONARY STRATA IN THE POSITIVE COLUMN OF A GAS DISCHARGE.
O.V.Prudkovskaya and M.F.Shirokov.
Dokl. Akad. Nauk SSSR, Vol. 112, No. 6, 1023-6 (1957). In Russian.

A theory is developed on the basis of a longitudinal balance between diffusion, ionization and volume recombination. A dispersion relation is found which leads to a stationary wavelength in fair agreement with experimental results for argon and neon at 10 mm Hg. H.Motz

537.525.5 : 621.387

7136. THEORY OF SPONTANEOUS OSCILLATIONS IN HOT-CATHODE MERCURY-VAPOUR TUBES. M.Hoyaux and P.Gans.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 42, No. 10, 1050-62 (1956). In French.

For background see Bull. Acad. Roy. Belgique Cl. Sci., Vol. 42, 961, 1956. The following phases of the oscillation process are distinguished: (1) penetration of the anode sheath; (2) excess ionization, consequent on (1), and in the form of variations round the equilibrium state; (3) increase in the anode fall in accordance with probe theory. When the anode fall increases sufficiently the sheath once more breaks down and the process repeats. A.H.W.Beck

537.525.6

7137. DETERMINATION OF THE COEFFICIENT OF DIFFUSION AND FREQUENCY OF IONIZATION IN MICROWAVE DISCHARGES.
M.P.Madan, E.I.Gordon, S.J.Buchsbaum and S.C.Brown.
Phys. Rev., Vol. 106, No. 5, 839-43 (June 1, 1957).

A method is presented for direct determination of the frequency of ionization and of the coefficient of free diffusion for electrons in a microwave discharge. The method is based on determining the rate of growth of the electron density in a microwave cavity in which an electric field larger than that necessary for breakdown is applied. The ionization frequency and the coefficient of free diffusion for electrons in hydrogen were measured in a pressure range of 15 to 45 mm Hg. Comparison is made with existing theory. A.

537.525.6

7138. ON THE DETECTION OF A SINGLE-ELECTRON AVALANCHE AND ITS SECONDARY PROCESSES IN GASES. J.K.Vogel and H.Raether.
Z. Phys., Vol. 147, No. 2, 141-7 (1957). In German.

Using a method based on techniques similar to those of proportional counters, single primary avalanches and their resultant secondary ionization are recorded oscillographically for air, $N_2$, $O_2$ and a mixture of $N_2$ and $CH_4$, for values of (pressure x distance) in the range 200 to 1000 (mm Hg) x (cm). In this way the secondary ionization processes operative in the growth of currents under uniform electric fields are studied; it is concluded that in air the photoelectric effect at the cathode predominates over electron emission by positive ions, and that in nitrogen the photoelectric effect alone is operative. J.Dutton

## X-RAYS 537.531

537.531

7139. THE STANDARDIZATION OF X-RAY OUTPUT IN INDUSTRIAL RADIOLOGY. R.S.Morgan, R.Halmshaw and B.J.Ratcliffe.
Brit. J. appl. Phys., Vol. 8, No. 2, 59-62 (Feb., 1957).

Variations in the output of radiation from different X-ray sets, when operated at the same nominal scale voltage, have been shown to be attributable to differences in the effective applied voltage. Such variations of output lead to difficulties in the standardization of radiographic techniques. More accurate calibration of the effective applied voltage has been shown to be required and it is suggested that considerable improvement could be obtained by calibrating the output of X-ray sets in terms of röntgens per minute and specifying exposures in röntgens. A.

537.531 : 537.533

7140. SIZE OF THE FOCAL SPOT IN A BETATRON. D.Greene.
Brit. J. appl. Phys., Vol. 8, No. 7, 293-5 (July, 1957).

The X-ray source in a 20 MeV betatron has been examined and has been found to be about 1 cm wide. It is suggested that there are two X-ray sources, the small platinum target and the "donut" wall, to which electrons may be scattered from the target. The resolving power of a finite sized ionization chamber is discussed in an appendix. A.

537.531 : 535.34

7141. THE K ABSORPTION SPECTRA OF PALLADIUM IN THE PURE METAL AND IN Pd—Au ALLOYS. C.Mande.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 747-9 (Feb. 4, 1957). In French.

The K discontinuity for palladium has been resolved into two parts for the first time. Slightly different positions of the discontinuity were found for two Pd—Au alloys. A.R.Stokes

537.531 : 535.33

7142. THE L-SERIES EMISSION SPECTRUM OF KRYPTON. H.R.Moore.
Proc. Phys. Soc. A, Vol. 70, Pt 6, 466-73 (June, 1957).

The L-spectrum of krypton has been observed in emission from an electrodeless discharge source and recorded photographically with a bent crystal spectrometer. Wavelength values are given for seven diagram lines ($L\beta_1$: 7547 X.U.; $L\alpha_{1,2}$: 7788 X.U.), one quadrupole line and ten satellite lines. The half-widths and intensities of the latter are compared with those of their parent lines $L\beta_1$ and $L\alpha_{1,2}$. The X-ray energy levels L I(1920 eV), M IV, V (87 eV) and N I (20 eV) are evaluated. A quasi-optical origin for some extra lines observed in this spectrum is proposed. A.

537.531 : 539.152.1

PRECISION MEASUREMENT OF X-RAY FINE STRUCTURE; EFFECTS OF NUCLEAR SIZE AND QUANTUM ELECTRODYNAMICS. See Abstr. 6473

537.531.7 : 539.166.75

7143. THE X-RAY AND $\gamma$-RAY ABSORPTION COEFFICIENTS OF A NUMBER OF GLASSES. D.A.Richardson.
Brit. J. appl. Phys., Vol. 8, No. 1, 11-14 (Jan., 1957).

From published data, the X-ray absorption coefficients of a number of glasses have been computed over a wavelength range of Q.01-1.0 A. The glasses are clear white plate, ceria stabilized plate, 1060 CRT glass, light barium crown 541595, lead plate glass and double extra dense flint glass 927210. The mass absorption coefficients for most oxides used in glassmaking are plotted as a function of wavelength, and a method of calculating the absorption coefficient of any glass from its composition and this graph is presented. Lead equivalents for the $\gamma$-ray region of some glasses are given as a function of glass density. The glasses considered are ceria stabilized plate; the barium series 541595, 572577, 612585 and 623603; and the lead series 653335, 700303, 748278, 801255, 927210 and lead plate glass. (The numbers given are the type reference numbers given in the catalogue of Chance optical glass). A.

537.531.8

7144. IONS PRODUCED BY X-RAYS IN THE AIR AT ATMOSPHERIC PRESSURE. A.Metnieks.
Ark. Fys., Vol. 11, Paper 42, 481-93 (1957).

Small ions formed in the atmospheric air by X-rays are measured. Ions of both signs are produced with approximately the same abundance. Frequently two groups with different mobilities have been found, especially in the case of positive ions. It is found that practically no large ions are generated by X-rays, but when the atmosphere already contains large ions, X-raying increases their concentration by 10-20% on account of the uncharged part of the nuclei. Conditions are discussed under which it is permissible to interchange n-values and ñ-values when drawing characteristics, that is, interchanging the instantaneous ion concentration and its accumulative value. A.

## CATHODE RAYS. POSITIVE RAYS 537.533/.534

537.533 : 537.534

7145. RADIATION EFFECTS ON FREE OSCILLATIONS IN SYNCHROTRONS. I.G.Henry.
Phys. Rev., Vol. 106, No. 5, 1057-61 (June 1, 1957).

Expressions are found for radial and vertical free-oscillation amplitudes in synchrotrons taking particular account of the radiation emission. In strong-focusing electron synchrotrons the radial oscillation may become undamped unless corrective measures are taken. A.

537.533.3

7146. SCALING OF SPACE-CHARGE LIMITED ELECTRON-OPTICAL SYSTEMS. M.E.Haine.
Brit. J. appl. Phys., Vol. 8, No. 1, 44 (Jan., 1957).

The scaling laws for a space-charge limited electron-optical systems are derived from simple field considerations. M.E.Haine

537.533.33 : 621.385.833

7147. THE ANALYSIS OF ROTATIONAL-SYMMETRIC POTENTIAL FIELDS IN ELECTRON LENSES. F.Lenz.
Ann Phys. (Leipzig), Vol. 19, No. 1-2, 82-8 (1957). In German.

Contains a critical discussion of two recent papers. Regenstreif's analysis of the three-electrode electrostatic aperture lens (Abstr. 8770/1951) is shown to imply incorrect boundary values of the assumed axial potential at infinity. A modified distribution is advanced, and the extension to the case of a thick central aperture considered. The results of Ehinger's analysis of the two-diameter magnetic lens (Abstr. 7483/1954) are compared with those derivable from a previous publication by the author (Abstr. 1103/1951), and shown to be less accurate, particularly with regard to the prediction of the position of maximum field strength, by reference to Liebmann's resistive network measurements (Abstr. 402/1956). E.A.Ash

537.533.35

7148. THE LIVES OF ELECTRON MICROSCOPE FILAMENTS. R.N.Bloomer.
Brit. J. appl. Phys., Vol. 8, No. 2, 83-5 (Feb., 1957).

The lives of the tungsten filaments used in electron microscopes can be limited by the thermal evaporation of the metal, or by chemical attack, in inferior vacua. The lives to be expected when either cause is dominant are calculated for a variety of operating conditions. Comparison of these calculated values with measured lives shows that thermal evaporation limits lives in microscopes used at high magnifications. The life limited by evaporation decreases as the temperature and thermionic emission increase, and so corresponding values of filament life and ideal gun output brightness (thermionic emission density per unit solid angle) have been calculated for normal working temperatures, in order that a compromise may be made. A.

537.533.35

7149. RESOLVING POWER OF AN EMISSION ELECTRON MICROSCOPE FITTED WITH A DIAPHRAGM, AND VELOCITY SPECTRUM OF TRANSMITTED ELECTRONS. C.Fert and R.Simon

C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1177-9 (Feb. 25, 1957). In French.

The diaphragm in an emission electron microscope intercepts electrons leaving the cathode with more than a certain critical velocity, thus narrowing the transmitted energy spectrum. The resolving power is independent of the initial energy spread.

A.E.I. Research Laboratory

537.533.74

7150. ELASTIC AND INELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS BY SOME (2p)-SHELL NUCLEI ON THE INTERMEDIATE-COUPLING MODEL. M.K.Pal and S.Mukherjee.
Phys. Rev., Vol. 106, No. 4, 811-16 (May 15, 1957).

The Møller potential has been used to describe the electron–nucleon interaction and a formula has been worked out in the Born approximation for the differential cross-sections of elastic and inelastic scattering of high-energy electrons by 2p-shell nuclei on the intermediate-coupling model with neglect of configuration mixing. Preliminary calculations have been made for $Be^9$ and $C^{12}$ to test some of the qualitative features of the formula deduced, especially the $\theta$-dependence of the $\sigma(\theta)$ v. $\theta$ curve for inelastic scattering with change of total angular momentum J. A.

537.533.74 : 530.145

7151. ELECTRON SCATTERING FROM THE DEUTERON AND THE NEUTRON–PROTON POTENTIAL. J.A.McIntyre and S.Dhar.
Phys. Rev., Vol. 106, No. 5, 1074-82 (June 1, 1957).

Electron scattering from the deuteron has been investigated experimentally at higher energies and larger scattering angles than before. Calculations have been made also for the scattering expected from deuterons with repulsive-core and with Yukawa-type neutron–proton potentials. As before, it is found necessary to introduce a proton size into the deuteron (or to modify the Coulomb interaction) in order to obtain agreement between the experimental results and the scattering calculations. Using the proton size determined by electron–proton scattering experiments, a comparison is made between the various calculated curves and the experimental data. It is found to be impossible to rule out either the repulsive-core or the Yukawa potentials. A.

537.533.74 : 539.152.1

7152. ELECTRON SCATTERING FROM NONSPHERICAL NUCLEI. B.W.Downs, D.G.Ravenhall and D.R.Yennie.
Phys. Rev., Vol. 106, No. 6, 1285-9 (June 15, 1957).

To explain the anomalously smooth cross-sections observed in electron scattering from certain nuclei (Hf, Ta, W, U), the contributions to the cross-section arising from the nonspherical character of those nuclei have been examined. Approximations are developed for the calculation of these contributions, and for a sample case, Ta, numerical results are given; the value required for the nuclear distortion in order to obtain agreement with experiment in this case is in good agreement with the spectroscopic and Coulomb-excitation values. The results suggest that in certain cases electron scattering will be a useful new method for measuring both the magnitude and the radial shape of nuclear deformations. A.

537.533.74 : 530.145

ELECTRON-STRUCTURE EFFECTS IN SCATTERING. See Abstr. 6890

537.534.74 : 539.172.13

PROTON–PROTON INTERACTIONS AT 410-660 MeV. See Abstr. 6540

537.533.75

7153. CONTRIBUTION TO THE STUDY OF THE RANGE–ENERGY CURVE FOR ELECTRONS OF 23 TO 90 keV IN A NUCLEAR EMULSION. J.Sacton.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 42, No. 11, 1118-22 (1956). In French.

The real and projected ranges in Ilford G5 emulsion were measured. The electrons used were accelerated to energies of 23, 46, 72, and 90 keV. J.M.Cassels

537.533.75

7154. PLASMA LOSSES BY FAST ELECTRONS IN THIN FILMS. R.H.Ritchie.
Phys. Rev., Vol. 106, No. 5, 874-81 (June 1, 1957).

The angle–energy distribution of a fast electron losing energy to the conduction electrons in a thick metallic foil has been derived assuming that the conduction electrons constitute a Fermi-Dirac gas and that the fast electron undergoes only small fractional energy and momentum changes. This distribution exhibits both collective interaction characteristics and individual interaction characteristics, and is more general than the result obtained by other workers. Describing the conduction electrons by the hydrodynamical equations of Bloch, it has been shown that for very thin idealized foils energy loss may occur at a value which is less than the plasma energy, while as the foil thickness decreases below $\sim v/\omega_p$ the loss at the plasma energy becomes less than that predicted by more conventional theories. The net result is an increase in the energy loss per unit thickness as the foil thickness is decreased. It is suggested that the predicted loss at subplasma energies may correspond to some of the low-lying energy losses which have been observed by experimenters using thin foils. A.

537.533.75 : 539.11

7155. RESONANCE POTENTIALS IN THIN FILMS OF POTASSIUM CHLORIDE. H.Jacobs, I.N.Greenberg, L.Goble and A.Ramsa.
Phys. Rev., Vol. 106, No. 5, 921-6 (June 1, 1957).

Experiments have been conducted in which potassium chloride films have been bombarded with slow electrons. Electron absorption and backscattering were studied as a function of bombarding energy. Discontinuities of slope were obtained at characteristic bombarding energies, and these were interpreted in terms of decomposition and excitation energies. Three different experimental arrangements were utilized; a triode with a rotating dynode in which the electrons describe a simple straight-line path from source to target to detector, a device wherein both the primary and backscattered electron beams followed a cycloidal path due to external magnetic field, and an apparatus containing a magnetic velocity analyser to limit the energy spread of the primary beam. General agreement was found in the data regardless of the type of apparatus used. The work function for inserting an electron into the potassium chloride film was estimated to be in the neighbourhood of 0.3 eV. It has been suggested that the technique of slow-electron bombardment may be used as a tool for analysis in thin-film studies and as a means of identifying band structure. A.

537.533.75 : 537.312.62

7156. ENERGY LOSS OF A CHARGED PARTICLE TRAVERSING SUPERCONDUCTORS. S.Hayakawa and K.Kitao.
Progr. theor. Phys., Vol. 16, No. 2, 131-8 (Aug., 1956).

The energy loss of a charged particle traversing superconductors is calculated by taking account of the London equations of the superconductivity. A small amount of excess energy loss, which is of the order of $10^{-2}$ or less, is expected, in comparison with the energy loss in normal materials. As this is just the limit of observability, an accurate measurement of the energy loss may give us information on the value of the characteristic constant of a superconductor, $\Lambda$, introduced by London. The excess loss relative to the normal energy loss is estimated as about $2m/e^2n\Lambda$, where m is the mass of an electron and n the density of electrons. A.

537.533.75

7157. INVESTIGATION OF THE ENERGY LOSS OF SLOW ELECTRONS IN NITROGEN. R.Haas.
Z. Phys., Vol. 148, No. 2, 177-91 (1957). In German.

The inelastic interaction of nitrogen molecules with electrons in the energy range 1-6.5 eV was measured by the electrical multiple collision method. The measurements were carried out in a mixture of nitrogen with a rare gas, the nitrogen percentage being varied from 2-20. Inelastic interaction begins about 1.5 eV, the cross-section showing a maximum value of 15% of the geometrical cross-section at ~2 eV. An explanation of the variation of the cross-section with energy is postulated in terms of the formation of an unstable $N_2^-$ complex. J.Hughes

537.533.8

7158. CIRCULAR POLARIZATION OF BREMSSTRAHLUNG FROM POLARIZED ELECTRONS IN BORN APPROXIMATION. K.W.McVoy.
Phys. Rev., Vol. 106, No. 4, 828-9 (May 15, 1957).

Some details are given of the theoretical derivation of the polarization for directly-forward bremsstrahlung. For 2 MeV incident electrons the theory predicts polarization rising to a maximum of 97% at the upper end of the spectrum. J.J.Wilkins

537.533.8

7159. EVIDENCE FOR CIRCULAR POLARIZATION OF BREMSSTRAHLUNG PRODUCED BY BETA RAYS. M.Goldhaber, L.Grodzins and A.W.Sunyar.
Phys. Rev., Vol. 106, No. 4, 826-7 (May 15, 1957).

Measurements are reported on the bremsstrahlung produced by a $\beta^-$ source ($Sr^{90} + Y^{90}$) enclosed in monel and lucite absorbers. The polarization was analysed by means of an electromagnet plus

scintillation counter arrangement. The results indicate ~90% polarization at the upper end of the bremsstrahlung spectrum.

J.J.Wilkins

537.533.8

7160. AUGER ELECTRONS IN THE SECONDARY ELECTRON SPECTRUM IN MAGNESIUM. O.H.Zinke.
Phys. Rev., Vol. 106, No. 6, 1163-4 (June 15, 1957).

By continuously depositing fresh magnesium onto a target surface in high vacuum, it was possible to obtain the spectrum of secondary electrons liberated from atomically clean metal. The results show excellent agreement with predicted Auger transitions, and the continuous background spectrum between Auger peaks vanishes. A.

537.533.8

7161. THEORY OF ELECTRON BREMSSTRAHLUNG IN THE REGION OF THERMAL ELECTRON VELOCITIES. K.Kummerer.
Z. Phys., Vol. 147, No. 3, 373-94 (1957). In German.

The Sommerfeld formula for energy loss is transformed so that it can be conveniently calculated. Most of this consists in putting the square of the hypergeometric function in this formula into a form which it can be evaluated approximately. An approximate formula is obtained for electron velocities of $\alpha c$, where $\alpha$ is the fine structure constant. In the infrared region, an even rougher approximation yields good results. Numerical examples are given and compared with the work of other authors.

G.E.Brown

537.533.8

7162. SECONDARY ELECTRON EMISSION OF SINGLE CRYSTALS OF NaBr. T.L Matskevich.
Zh. tekh. Fiz., Vol. 26, No. 10, 2399-400 (1956). In Russian.

Results of measurements on five single crystals of NaBr. Curves of secondary emission coefficient ($\sigma$) against primary voltage are given. The maximum value of $\sigma$ at room temperature for normal incidence was 24, occurring at 1800 volts. For $50^0$ incidence, $\sigma_{max} = 30$ (at 3000 volts). The value of $\sigma$ decreased rapidly with increasing temperature. J.B.Arthur

537.533.9 : 535.14

7163. A QUANTUM THEORY OF REFRACTIVE INDEX, ČERENKOV RADIATION AND THE ENERGY LOSS OF A FAST CHARGED PARTICLE. D.A.Tidman.
Nuclear Physics, Vol. 2, No. 4, 289-346 (Dec., 1956).

A quantum theory of the three related subjects of refractive index, Cherenkov radiation, and the excitation and ionization of atoms in a polarizable medium is developed. The classical theory of the electromagnetic field in a medium of extended dipoles is first written in Hamiltonian form. This makes obvious a canonical transformation related to refractive index which enables one to express the total field in the medium as a superposition of oscillators. A similar transformation is made on the quantized radiation field variables, which takes account of the modified time dependence of the field due to its interaction with the medium. The processes of Cherenkov radiation and the ionization and excitation of atoms in a polarizable medium are then treated. The partition of the total energy loss between these different primary processes is obtained directly. This is done by making a perturbation expansion on the basis of physical-photon states for processes caused by the passage of a fast charged particle through the medium. For the case in which the reaction of the medium on the particle is neglected formulae are obtained which agree with those obtained previously by other authors i.e., in the first approximation the quantum theory frequently gives the same result as the classical theory for these processes. A.

537.533.9 : 621.372.8

7164. CHERENKOV EFFECT AT MICROWAVE FREQUENCIES. J.G.Linhart.
Onde élect., Vol. 36, 979-88 (Nov., 1956). In English and French.

It is shown that the interaction of an electron beam with the surface wave on a dielectric waveguide may be interpreted as an example of the Cherenkov effect. The design of oscillators utilizing a tubular dielectric slow-wave structure, for X- and Q-band, is indicated. Ease of construction, and the possibility of increasing the efficiency by a uniform increase of d.c. potential along the length of the guide, are regarded as advantages which might outweigh the very low interaction impedance which can be attained.

E.A.Ash

537.534

7165. ON THE ACCELERATION OF NEGATIVE IONS IN A CYCLOTRON. B.T.Wright.
Arch. Math. Naturvid., Vol. 54, Paper 2, 10 pp. (1957).

By considering the scattering of the electrons which are carried by $H^-$ ions, an evaluation has been made of the electron detachment cross-section per atom of air. Based on these results the survival of $H^-$ ions upon their acceleration in a cyclotron was determined. The production, by the stripping of accelerated $H^-$ ions, of useful external beams is feasible up to about 50 MeV, even for synchrocyclotrons, provided special attention is given to certain features of design. A.

537.534

7166. LINEAR DYNAMICS IN SPIRAL RIDGE CYCLOTRON DESIGN. W.Walkinshaw and N.M.King.
Atomic Energy Res. Establ. (Harwell) Rep. GP/R2050, 32 pp. (1956).

A linearized form of the equations of motion is developed and used to derive expressions for the radial and vertical oscillation frequencies. Taking account of practical requirements, these relations are used to survey possible design parameters for two spiral ridge cyclotrons — a 240 MeV fixed-frequency machine, (conversion of 110 in. Harwell synchrocyclotron), and a high energy (3 BeV) accelerator. Particular emphasis is laid on the limitations imposed by the various resonances associated with spiral ridge systems. On this basis it is concluded that the Harwell conversion might be achieved with four ridges ($N = 4$) on the magnet pole face. A composite ridge system is suggested for the high energy machine, with N small near the centre, the number of ridges being doubled before the 240 MeV resonance is encountered. Owing to the prohibitive integral resonance occurring at some energy depending on the chosen N, but always <938 MeV, the last part of the acceleration must be accomplished with the aid of frequency modulation. The mean field could then have a power law variation, with constant spiral angle, and the working point on the resonance chart would remain fixed. The necessity of extensive non-linear computations in establishing the feasibility of the proposed designs is stressed; the linear dynamics indicates the course which the more accurate studies should take. A.

537.534 : 621.384.612

7167. STRONG FOCUSING IN ALTERNATING GRADIENT SYNCHROTRON PARTICLE ACCELERATORS. P.Lapostolle.
Onde élect., Vol. 37, 41-7 (Jan., 1957). In French.

A sketch of the basic theory, and a short account, with a list of dimensions, of the C.E.R.N. machine. J.S.Bell

537.534.71 : 537.534.8

7168. ON THE ION REFLECTION AND SECONDARY ELECTRON EMISSION IN THE COLLISION OF ALKALI IONS WITH PURE MOLYBDENUM SURFACES. C.Brunnée.
Z. Phys., Vol. 147, No. 2, 161-83 (1957). In German.

An experimental study is made of the ions reflected and the electron emission produced when alkali ions, selected by a mass spectrometer and with energies in the range 0.4 to 4 keV, fall on Mo surfaces. Curves are given showing: (1) the dependence of the reflection coefficient $\rho$ [(reflected ion current)/(incident ion current)] on the state of the surface and on the mass and energy of the incident ions; (2) the energy distribution of the reflected ions and of the secondary electrons; (3) the dependence of the secondary coefficient [(secondary electron current)/(primary ion current)] on the nature and energy of the incident ions. J.Dutton

537.534.71 : 537.534.8

7169. THEORY OF THE REFLECTION OF POSITIVE IONS AT METAL SURFACES. O.v.Roos.
Z. Phys., Vol. 147, No. 2, 184-209 (1957). In German.

A theory based on a quantum-mechanical treatment of the diffusion of ions which penetrate the metal lattice is developed. Calculations are made of the reflection coefficient and energy distribution of the reflected ions and the values obtained compared with the results obtained in a concurrent experimental investigation (see preceding abstract). J.Dutton

537.534.71 : 537.534.8

7170. THEORY OF THE KINETIC EMISSION OF SECONDARY ELECTRONS, LIBERATED BY POSITIVE IONS. O.v.Roos.
Z. Phys., Vol. 147, No. 2, 210-27 (1957). In German.

Continuation of previous work (see preceding two abstracts). The theory is developed further and used to calculate the energy spectrum of electrons produced by alkali ions of energy about 1-10 keV incident on a Mo surface, a case for which "potential emission" is unimportant. The theoretical results, which are in good agreement with experiment (see preceding abstract) show that the energy spectrum depends on the principal quantum number of

the outer closed shell of the incident ion and that there is a pronounced "isotope effect" for incident ions of equal velocity.

J.Dutton

537.534.74 : 539.185

7171. ELASTIC NEUTRON–PROTON SCATTERING AT 380 MeV. V.P.Dzhelepov and Yu.M.Kazarinov.
Dokl. Akad. Nauk SSSR, Vol. 99, No. 6, 939-42 (1954). In Russian.

Proportional counters in coincidence were used to detect the scattering events occurring in equivalent layers of carbon and paraffin, and the contribution of the n–p events was determined by a difference method. The calibration of the neutron beam and the experimental procedure are described in detail. Accurate values of the cross-section in the centre-of-mass system from about 20° up to 180° are given. A set of conclusions and a number of possible interpretations are discussed. G.Martelli

537.534.74 : 539.185

7172. PHENOMENOLOGICAL TWO-NUCLEON POTENTIAL UP TO 150 MeV. P.S.Signell and R.E.Marshak.
Phys. Rev., Vol. 106, No. 4, 832-4 (May 15, 1957).

It is found that the addition of a spin–orbit force to the Gartenhaus central-tensor mixture (Abstr. 921/1956) leads to good agreement with all two-nucleon differential cross-section and polarization measurements up to 150 MeV. J.W.G.Wignall

537.534.74 : 539.152.1

7173. ANGULAR DISTRIBUTION OF 424 MeV POLARIZED PROTONS ELASTICALLY SCATTERED FROM VARIOUS NUCLEI. E.Heiberg.
Phys. Rev., Vol. 106, No. 6, 1271-9 (June 15, 1957).

Measurements have been made of the polarization and the angular distribution of 424 MeV protons elastically scattered from carbon, aluminium, iron, and silver. The results clearly indicate the importance of separating the elastic scattering from scattering involving excited states of the nucleus. By the inclusion of inelastic scattering, the dips in the cross-section curves and the details in the polarization curves get smeared out. The carbon data show reasonable agreement with similar work by Chesnut (Abstr. 1954/1957). Elastic cross-sections were estimated by extrapolating the differential cross-section curves to zero degrees using the optical model of the nucleus. A nuclear radius was calculated from the location of the first diffraction minima in the cross-section curves for the various elements. Using the optical model, an average value $r_0 = 1.03 \times 10^{-13}$ cm was obtained. The Born approximation gave $r_0 = 1.2 \times 10^{-13}$ cm. A.

537.534.75

7174. ON THE RANGE–ENERGY RELATION FOR $Li^7$ IONS IN ILFORD C-2 NUCLEAR EMULSIONS. J.P.Lonchamp.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1486-8 (March 11, 1957). In French.

The charges particles produced by bombarding Be with 375 MeV alpha-particles, after magnetic analysis have been allowed to enter at glancing incidence Ilford C-2 nuclear emulsions placed at different values of $H\rho$. The $Li^7$ group is identified amongst these particles and the energy is deduced from that of the protons of the same $H\rho$. Six points on the range–energy relation curve of $Li^7$ ions have been thus determined. The curve from 0.8-99 MeV is discussed in the light of other recent measurements. Serious discrepancies exist in the region below 3 MeV. D.J.A.Prowse

537.534.75

7175. STOPPING POWER OF SOME METALLIC ELEMENTS FOR 19.8 MeV PROTONS. V.C.Burkig and K.R.MacKenzie.
Phys. Rev., Vol. 106, No. 5, 848-51 (June 1, 1957).

The proton beam of a cyclotron, adjusted to 19.8 MeV, was used to measure the stopping power per electron relative to aluminium for 23 elements from Be to Th. An approximate straight-line relationship was found as a function of log Z with deviations noted from Ta to Th, and also from Ca to Fe. The latter deviation seems to be associated with the number of electrons in the 3d shell. A.

537.534.8

7176. ON THE ENERGY DISTRIBUTION OF THE SECONDARY ELECTRONS LIBERATED BY PROTONS IN GASES. E.Blauth.
Z. Phys., Vol. 147, No. 2, 228-40 (1957). In German.

A method of measuring the energy spectrum of secondary electrons liberated at an angle of 54.5° from $N_2$, $H_2$, Kr, A and He by collision with protons of energy 49, 11.8 or 8.8 keV is described. The results are given graphically and show that the number of electrons with energy in the range E to E+dE is $E^{-\beta}dE$, where $\beta$ is a constant lying between 3 and 4 over specified ranges in all the gases studied. The curves are discussed in relation to the calculated maximum energy transfer from proton to electron and its dependence on the electronic structure of the gas atom. J.Dutton

# DISCHARGE TUBES. COUNTERS 537.54

537.542

7177. A PHOTON COUNTER OF HIGH SENSITIVITY FOR THE VACUUM ULTRA-VIOLET REGION. D.W.Turner.
Nature (London), Vol. 179, 1022-3 (May 18, 1957).

Describes the use of copper iodide, instead of a pure metal, as a photo-emissive surface in a photon counter using gas amplification (Abstr. 138/1948, 3266/1949) but confining its operation to the proportional region to obtain linear response. It was found that the use of a fluorite window and methane filling at 12 mm pressure resulted in sensitivity to the vacuum ultraviolet radiation. No marked change in sensitivity was observed between 2000 A and 1450 A, and the quantum efficiency of between $10^{-2}$ and 1, in the region of 1850-2150 A, was obtained. J.M.Zarzycki

537.542 : 539.16.08

7178. AN EXPERIMENTAL EXAMINATION OF THEORIES OF CAVITY IONIZATION. J.R.Greening.
Brit. J. Radiol., Vol. 30, 254-62 (May, 1957).

Measurements have been made of the relative ionization in small air-filled condenser chambers of graphite, copper, tin, tantalum and lead, exposed to $Co^{60}$, $Cs^{137}$ and $Au^{198}$ radiations. The variation of ionization with pressure between about 5 and 76 cm of Hg for these chambers and radiation sources was also investigated. In general the results agree well with the Spencer–Attix theory of cavity ionization, but there remain some small differences which are attributed chiefly to the cavity distorting the electron spectrum crossing it. A.

537.542

7179. THE NEON FLASH TUBE AS A DETECTOR OF IONIZING PARTICLES. M.Gardener, S.Kisdnasamy, E.Rössle and A.W.Wolfendale.
Proc. Phys. Soc. B, Vol. 70, Pt 7, 687-99 (July, 1957).

A new type of particle detector developed recently by Conversi and his co-workers consists of a glass tube filled with neon which, after traversal by an ionizing particle, can be made to glow by the application of a strong electric field. In this paper details are given of a systematic study of the "flash tubes" with a view to the production of a particle detector of high efficiency and low cost. It has been found that the requirements for high efficiency are not rigorous: relatively impure gas can be used and time delays of several microseconds between the traversal of the particle and the application of the field can be tolerated. The limitations imposed by the presence of spurious flashes, i.e. flashes not associated with ionizing particles, are discussed. A.

537.542 : 539.185.08 : 621.374.32

7180. A 1000-CHANNEL NEUTRON-VELOCITY SPECTROMETER USING FERRITE DATA STORAGE.
F.H.Wells and J.G.Page.
Proc. Instn Elect. Engrs, Paper 2380R, publ. 1957 (Part B Suppl. No. 7, 470-80, 481-2).

Describes the electronic sorting and counting equipment for a spectrometer using "time of flight" techniques in the energy range 1-1000 eV, the neutron source being a nuclear reactor in conjunction with a mechanical shutter. This provides bursts of neutrons at about 0.25 $\mu$sec duration and 1000 pulses/sec repetition rate. After passing through the test specimen, the neutrons are sorted into 1000 energy channels and the number of neutrons counted in each channel during the experiment is scaled and recorded. Thus 1000 numbers must be stored. Each number store takes the form of ten 2 mm ferrite torodial cores, and the 1000 channel store is arranged as a matrix of 1000 x 10 cores, controlled from a common 10-stage transistor binary scaler. Selection of each channel requires the use of an address matrix of a thousand 8 mm cores arranged in a 10 x 10 x 10 matrix. At the end of the experiment the contents of the store may be taken out on to a punched-tape machine. A

537.542 : 621.374.32

7181. THE APPLICATION OF SQUARE-LOOP FERRITE MATERIAL IN DATA-PROCESSING SYSTEMS. E.P.G.Wright.
Proc. Instn Elect. Engrs, Paper 2234R, publ. Oct., 1956 (Part B Suppl. No. 7, 502-11, 523-5).

Republication, with discussion, of the paper abstracted in Abstr. 1407 (1957).

537.542

7182. TEMPERATURE AND PRESSURE MEASUREMENTS IN AN OVER-COMPRESSION CLOUD CHAMBER.
D.W.Hadley, J.C.Bower and J.Walker.
J. sci. Instrum., Vol. 33, No. 12, 507-8 (Dec., 1956).

Uses the 9 in. dia. horizontal chamber (Abstr. 2971/1956) filled with dry argon, and a specially constructed Pt resistance-thermometer in a Wheatstone bridge. The off-balance voltage was measured using a cathode-ray oscillograph and typical traces are shown for both balanced and unbalanced cycles. Temperature changes due to turbulent gas motions accompanying expansion and overcompression were observed. K.H.Barker

537.542

7183. THE MEASUREMENT OF THE MOMENTA OF HIGH ENERGY CHARGED PARTICLES IN A DIFFUSION CLOUD CHAMBER. B.B.Culwick.
J. sci. Instrum., Vol. 34, No. 4, 154-8 (April, 1957).

The problems associated with the measurement are described. An optical system has been developed for which the apparent curvatures in the object due to distortion have an average value of 0.005 $m^{-1}$ over the field of view. Spurious track curvatures due to convective gas motions within the cloud chamber are of similar magnitude, when a flash delay time adequate to allow the photography of the tracks of minimally ionizing particles in hydrogen is used. These figures result in a nominal accuracy of about 2% in the momentum of a 1000 MeV proton (momentum $1.7 \times 10^9$ eV/c) in a magnetic field of $1.3 \times 10^4$ G for tracks 20 cm long. The corresponding maximum detectable momentum is $8.5 \times 10^{10}$ eV/c. A.

537.542 : 535.43

7184. PRODUCTION OF CLOUDS OF REQUIRED DROP-SIZES BY THE APPLICATION OF MIE SCATTERING.
M.M.Paranjpe and N.K.Subramanian.
J. Univ. Bombay, Vol. 24, Pt 3, 44-50 (Nov., 1955).

Calculations were made to test the equivalence of the Mie theory and the diffraction theory for disks, for water drops with $\alpha$ ($= 2\pi r/\lambda$) up to 35. The positions of the first minimum and the first maximum of scattering were used to determine the size of drops produced in an expansion cloud-chamber. A.R.Stokes

537.542

7185. A CARBON DIOXIDE–HEXANE GAS BUBBLE CHAMBER.
B.Hahn.
Nuovo Cimento (Ser. 10), Vol. 4, No. 4, 944-5 (Oct., 1956).

A preliminary report of experiments using several organic liquids with $CO_2$ and argon. Bubble formation due to radiation was observed for $CO_2$–n.hexane and $CO_2$–triethylamine using pre-expansion pressures up to 50 atm, but not for pure $CO_2$. K.H.Barker

537.542

7186. ON THE BUBBLES FORMATION IN SUPERSATURATED GAS–LIQUID SYSTEMS. P.E.Argan and A.Gigli.
Nuovo Cimento (Ser. 10), Vol. 4, No. 4, 953-7 (Oct., 1956).

A relationship proposed by Glaser (Abstr. 10767/1954) based on a simple electrical model was used to predict the operating conditions of the hydrogen-rich systems methane–pentane and carbon dioxide–pentane which only require pre-expansion pressures of 20-30 atm. Despite the probable limitations of the Glaser formula, experiments carried out using the chamber previously described (Abstr. 5980/1956) confirm the predictions. The properties of the two systems are given in tabular form. K.H.Barker

537.543 : 621.385.16.029.6

7187. THE RELATIVISTIC MAGNETRON AND THE EFFECTIVE MASS ANISOTROPY. J.A.Bradshaw; L.Gold.
J. Electronics, Vol. 2, No. 4, 406; Corrigendum, 407-8 (Jan., 1957).

An error due to the inclusion of a non-relativistic equation (16) in Gold's paper (Abstr. 491/1957) is pointed out. Gold now provides a corrected derivation for the cut-off of the relativistic cylindrical magnetron. C.A.Hogarth

# IONIZATION. THERMIONICS 537.56/.58

537.56

7188. ON THE GENERAL STUDY OF IONIZING FIELDS.
J.Dupuy.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1737-9 (March 25, 1957). In French.

Completes previous work (Abstr. 6586/1956) with a short discussion of ionizing fields and probe measurements when both positive and negative ions are present. J.Dutton

537.561 : 537.542

7189. PHOTOIONIZATION COUNTER FOR DETERMINATION OF IONIZATION POTENTIAL. H.Sakai, J.W.Little and K.Watanabe.
J. chem. Phys., Vol. 26, No. 5, 1335-6 (May, 1957).

Extends previous work (Abstr, 553 and 11164/1954) on the measurement of ionization potentials and continua, by using as a detector a G.M.-type photon counter to improve the resolution to 0.001 eV. An ionization curve for $CS_2$ in the range 1200-1270 A is given and discussed. J.Dutton

537.562

7190. THE FORMATION OF $H_2^+$ MOLECULES DURING A DECAYING PLASMA IN IONIZED HYDROGEN.
R.Herman, S.Weniger and L.Herman.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1746-8 (March 25, 1957). In French.

Discusses de-ionization phenomena in hydrogen (spark) plasmas, using experimentally determined values of recombination coefficients as functions of time. The authors explain the results by suggesting the formation of $H_2^+$ from $H_2$ in the cooling plasma; initially, the high discharge temperature gives practically complete dissociation. J.D.Craggs

537.562

7191. AN R.F. PROBE TECHNIQUE FOR THE MEASUREMENT OF PLASMA ELECTRON CONCENTRATIONS IN THE PRESENCE OF NEGATIVE IONS. T.H.Y.Yeung and J.Sayers.
Proc. Phys. Soc. B, Vol. 70, Pt 7, 663-8 (July, 1957).

A method of measuring the electron population in the presence of both positive and negative ions has been developed. The method is based on the measurement of the local plasma electron resonance frequency, from which the free electron density may be calculated on the assumption that the relative influence of the ions is negligible. The validity of this technique has been confirmed by checking its results with those obtained by the Langmuir probe method in a d.c. discharge in noble gases; the limitations of the method and some factors which influence the measurements have also been noted. It was found that the method can be used in a continuous high-frequency electrodeless discharge where the normal wire probe methods are of doubtful validity. The technique has been applied to a study of the decay of electron density in the afterglow of a pulsed discharge in iodine vapour; the cross-section of electron attachment $\sigma$ was found to be $7.5 \pm 0.5 \times 10^{-18}$ $cm^2$ for electrons at an estimated temperature of 8000°K. A.

537.583 : 621.385.032.213.13

7192. THE NATURE OF THE EMITTING SURFACE OF BARIUM DISPENSER CATHODES. I.Brodie and R.O.Jenkins.
Brit. J. appl. Phys., Vol. 8, No. 1, 27-9 (Jan., 1957).

Data concerning the thermionic emission and evaporation characteristics of various barium dispenser cathodes are examined. It is deduced that the tungsten surface of an "L"-type cathode must be covered with a layer of oxygen on which the barium is adsorbed. The thermionic emission from cathodes impregnated with barium aluminate results from a similar layer on the tungsten, the emission from the impregnant at the ends of the pores contributing relatively little. When the impregnant is barium–calcium–aluminate, however, the considerable increase in emission is mainly due to enhancement of the emission from the impregnant and not to an increase in that from the activated tungsten. It is postulated that the emitting surface of the impregnant may be a thin layer of calcium oxide activated by barium. A.

537.583 : 621.385.032.213.13

7193. THE EFFECT OF SULPHUR AND OXYGEN ON THE ELECTRICAL PROPERTIES OF OXIDE-COATED CATHODES.
G.S.Higginson.
Brit. J. appl. Phys., Vol. 8, No. 4, 148-9 (April, 1957).

Poisoning and recovery experiments using both oxygen and sulphur substantiate the Loosjes and Vink theory of conduction. Sulphur is found to have a greater poisoning effect than oxygen. A possible reason for this is suggested. A.

537.583

7194. EVAPORATION OF BARIUM FROM IMPREGNATED CATHODES. I.Brodie and R.O.Jenkins.
J. Electronics, Vol. 2, No. 5, 457-76 (March, 1957).

An experimental study was made by observing the emission from a tungsten wire exposed to the evaporated Ba. The major conclusion was that the addition of calcium to the barium oxide–

alumina system materially reduces the rate of evaporation. The evaporation rate for an emission density of 1A/cm$^2$ is $5 \times 10^{-12}$ g cm$^{-2}$ sec$^{-1}$ for $3BaO.Al_2O_3 + \frac{1}{2}CaO$, which is about one tenth the evaporation rate for "L" cathodes. A.H.W.Beck

# COSMIC RAYS 537.591

537.591.1 : 539.18

7195. THE PENETRATING COMPONENT OF COSMIC RAYS AT GREAT DEPTHS. L.Avan.
Ann. Phys. (Paris), Ser. 13, Vol. 1, 870-913 (Nov.-Dec., 1956). In French.

A condensed doctoral thesis of three chapters on the properties of energetic $\mu$-mesons. Measurements of the intensity and angular distribution were made at depths of 300, 580 and 1280 m water equivalent using photographic emulsions. Comparisons are made between these observations and the results expected on the basis of the Budini—Molière cascade theory assuming that some of the $\mu$-mesons were the decay products of $K_\mu$-mesons. There is no evidence that a significant fraction were produced in this way. From observations of 8 interactions and 50 single nuclear particles at 300 m water equivalent a cross-section lying between 12 and 18 microbarns is deduced, for $\mu$-mesons at 100 GeV. The bibliography, completed in 1954, contains 81 references. K.H.Barker

537.591.1

7196. THE RATIO OF THE NUMBER OF PHOTONS TO THE NUMBER OF ELECTRONS IN EXTENSIVE AIR SHOWERS OF COSMIC RADIATION.
J.Babecki, L.Jurkiewicz, J.M.Massalski and M.Mięsowicz.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 4, No. 12, 817-21 (1956).

The ratio p/e found by a modified anticoincidence method agreed with that given by the ordinary method, the average value being 0.70 ± 0.15 for showers of mean density 10-20 particles per square metre. This is smaller than the value ≥ 1 predicted by one-dimensional cascade theory. E.J.Burge

537.591.1

7197. ELECTRON—PHOTON COMPONENT OF COSMIC RAYS AT GREAT DEPTHS. L.Avan and M.Avan.
C.R. Acad. Sci. (Paris), Vol. 244, No. 4, 450-2 (Jan. 21, 1957). In French.

The electron—photon component of cosmic-rays underground has been studied with nucleon emulsions exposed under 15 cm lead at three different depths in iron mines (–300 metres, –580 metres, and –1280 metres water equivalent). The integral energy spectrum and the zenith-angle distribution law is deduced for electrons and photons with energies between 30 and 150 MeV. P.Rothwell

537.591.15 : 539.172.3

7198. INVESTIGATION OF AN ELECTROMAGNETIC CASCADE OF VERY HIGH ENERGY IN THE FIRST STAGE OF ITS DEVELOPMENT IN NUCLEAR EMULSIONS.
M.Mięsowicz, O.Stanisz and W.Wolter.
Bull. Acad. Polon. Sci. Cl.3, Vol. 4, No. 12, 811-15 (1956).

For a single primary photon of about $7 \times 10^{11}$ eV energy, the number of electrons of energy $< 5 \times 10^8$ eV at a depth of 1.55 radiation lengths was found to be smaller than that predicted by cascade theory, but could be explained qualitatively in terms of recent suggestions by Dyson and others. E.J.Burge

537.591.15

7199. ON THE GENERAL THEORY OF THE NUCLEAR CASCADE PROCESS. G.T.Zatsepin and I.L.Rozental'.
Dokl. Akad. Nauk SSSR, Vol. 99, No. 3, 369-72 (1954). In Russian.

A generalization of previously developed methods to investigate the formation of mixed air showers. Whilst former investigations have been based on the assumption that particles produced in the interactions all had the same energy, the present one is carried out assuming a generation spectrum for secondary particles and an energy-dependent cross-section for the successive interactions. G.Martelli

537.591.15

7200. ON THE STRUCTURE OF EXTENSIVE COSMIC RAY AIR SHOWERS: CORE DETECTION AND CORE STRUCTURE.
E.W.Kellermann, T.Shaw and N.Dickinson.
Proc. Phys. Soc. A, Vol. 70, Pt 6, 452-9 (June, 1957).

A "core-detecting" apparatus is described for which the efficiency of core detection is uniform for central electron densities from about 20 to 200 m$^{-2}$. Accuracy of location of shower axes has been studied by means of decoherence curves between two identical units; more than 50% of responses are shown to arise from showers for which the axis falls within 3 m of the centre of the detector. The performance of the core detector is shown to be consistent with the conclusion that the proportion of energetic electrons in the centre of showers changes little over the range of shower size examined, and in particular that the smaller showers do not show the characteristics of "old" cascades. The observations provide no evidence of any core structure of size comparable with the measured accuracy of location. A.

537.591.15

7201. ON THE ENERGY DEPENDENCE OF THE CROSS-SECTION FOR THE PRODUCTION OF THE PENETRATING SHOWER UNDERGROUND. S.Higashi, M.Oda, T.Oshio, H.Shibata, K.Watanabe and Y.Watase.
Progr. theor. Phys., Vol. 16, No. 3, 250-1 (Sept., 1956).

The authors suggest a semi-empirical formula to fit the observed cross-sections; this has a slightly stronger energy dependence than that used by George and Evans. J.W.G.Wignall

537.591.2

7202. THE PATHS OF COSMIC RADIATION PARTICLES IN THE EARTH'S MAGNETIC FIELD.
R.Lüst, A.Schlüter and K.Katterbach.
Nachr. Akad. Wiss. Göttingen, Math.-Phys. Kl. IIa, No. 8, 128-222 (1955). In German.

About 400 of these have been calculated. The impact parameters have been chosen to allow for particles of energy $10^9$ eV to arrive on the earth. Paths have been calculated, too, for different source declinations. The work gives the fundamental equations, describes the numerical methods employed and contains a short discussion of the results. About 80 pages are taken up by the extensive tables and diagrams. E.W.Kellermann

537.591.5

7203. VARIATIONS IN INTENSITY OF COSMIC RAYS ON JANUARY 21, 22 AND 23, 1957.
J.P.Legrand, P.Chanson and M.Bonpas.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1362-4 (March 4, 1957). In French.

A strong magnetic storm on Jan. 21 was accompanied by cosmic-ray intensity variations. An unshielded vertical meson-telescope showed first an increase of ~ 4%, followed by a sharp decrease to ~ 8% of normal intensity. A wide-angle telescope under 11 cm lead showed no variation during this period. It is suggested that the intensity increase observed prior to the characteristic intensity decrease, can be associated with a chromospheric eruption which occurred at 15 hr 13 min on Jan. 21. P.Rothwell

# MAGNETISM 538

538.11

7204. MAGNETIC INTERACTION IN A SYSTEM OF DIPOLES.
G.Karpman.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1336-9 (March 4, 1957). In French.

The interaction forces and energy are calculated using a hydrodynamic model, and application is made to the spin-wave theory of ferromagnetism. E.P.Wohlfarth

538.114

7205. SEMICLASSICAL MODEL OF SPIN WAVES IN A FERRIMAGNETIC MEDIUM. H.Cofta.
Acta phys. Polon., Vol. 15, No. 5, 311-19 (1956). In German.

The dispersion relation $\omega(k) \sim k^2$ is derived for ferrimagnetic and antiferrimagnetic media (see Abstr. 4201/1953, 8895/1955). E.P.Wohlfarth

538.114 : 518.5

7206. AN ELECTRICAL ANALOGUE OF MAGNETIC DOMAINS. P.F.Davis.
Brit. J. appl. Phys., Vol. 8, No. 1, 19-20 (Jan., 1957).

An electrical analogue which may be used for finding either the magnetic energy or the field associated with a domain structure consists of a square mesh network of resistance wires composed of different gauges of wire running in different directions; the wires having the highest resistance per unit length run in the direction analogous to the direction of magnetization of the domain (a three-dimensional form might consists of parallel plates of resistive material immersed in an electrolytic tank). A.

538.114

7207. NUCLEAR MAGNETIC RELAXATION IN ANTIFERROMAGNETICS. T.Moriya.
Progr. theor. Phys., Vol. 16, No. 1, 23-44 (July, 1956).

The mechanism of the thermal relaxation of nuclear spins related with the nuclear magnetic resonance in antiferromagnetics is studied theoretically. The predominant mechanism is provided by the fluctuating local magnetic field at the nucleus coming from the electron spins which flip from time to time due to exchange interactions among them. At low temperatures this mechanism can be described in terms of the inelastic scatterings of spin waves by nuclear magnetic moments, and the thermal transition probability can be calculated from this point of view. At high temperatures the relaxation time is obtained from the local field spectra which are calculated with the use of the high-temperature approximation assuming a Gaussian distribution. The calculated relaxation time of protons in $CuCl_2.2H_2O$ agrees well with the experiment both in order of magnitude and in the qualitative nature of its temperature dependence. However, for $MnF_2$, whose nuclear resonance has not yet been observed in the range 300-1.5°K, the calculated relaxation time is always longer than $10^{-5}$ sec and it becomes rapidly longer as temperature is lowered. This contradicts with the interpretation of Bloenbergen and Poulis who accounted for the absence of the resonance by assuming that $T_1$ is shorter than $10^{-6}$ sec. As a possible origin of the absence of the resonance in the frequency range of their observation, effect of the hyperfine interaction is suggested. A.

538.114

7208. NUCLEAR MAGNETIC RELAXATION IN ANTIFERROMAGNETICS. II. T.Moriya.
Progr. theor. Phys., Vol. 16, No. 6, 641-57 (Dec., 1956).

Theory of nuclear magnetic relaxation in antiferromagnetics treated in the preceding abstract for non-magnetic ions is extended to the case of magnetic ions. Strong hyperfine intereactions and quadrupole interactions are the distinctive feature of the problem. The line width and the relaxation rate are calculated by using the spin-wave approximation at low temperatures and the model of Gaussian random modulation at high temperatures. Order estimations of $T_1$ and $T_2$ are made for several substances, which predict that the nuclear resonance will be difficult to detect above the Curie point because of the broadening due to the hyperfine interaction, while the resonance will become detectable at sufficiently low temperatures where the low frequency components of the local field spectra decrease remarkably. The effects of the quadrupole interaction are also discussed. A.

538.114

7209. A THEORY OF METALLIC FERRO- AND ANTIFERROMAGNETISM ON ZENER'S MODEL. T.Kasuya.
Progr. theor. Phys., Vol. 16, No. 1, 45-57 (July, 1956).

The importance to the mechanism of ferromagnetism of exchange interaction between conduction electrons and unfilled inner shell electrons (called s–d interaction) has been pointed out by Zener. Especially for rare-earth metals, this interaction seems to be the only mechanism which can cause ferro- and antiferromagnetism. However, Zener's model is unsatisfactory because it is phenomenological and moreover does not involve antiferromagnetism and spin-wave mode. The present paper considers this s–d interaction on a more rigorous basis. By a certain approximation, there appear long-range exchange-type interactions between d-electron spins and, in certain conditions both ferro- and antiferromagnetism appear. The excitations of spin-wave modes are the same as those in the ordinary modes of the short range exchange force, viz, the energy of the spin-wave excitations proportional to $q^2$ for ferromagnetism and q for antiferromagnetism in the region of small wave vector q. The $T^{3/2}$ law for the temperature dependence of the magnetization of ferromagnetism is applicable up to very high temperatures, and this result is in good agreement with the results of experiments on metallic ferromagnetism. A.

538.122.08

7210. THE MEASUREMENT OF INHOMOGENEOUS MAGNETIC FIELDS IN NARROW GAPS. J.Knizak.
Acta phys. Austriaca, Vol. 10, No. 3, 186-9 (1956). In German.

Apparatus making use of the potential difference developed, in the presence of a magnetic field, between two electrodes in a stream of mercury has been developed for the measurement of the magnetic field in a volume of 1 $mm^3$. A.E.De Barr

538.122.08 : 538.632

7211. ON CERTAIN POSSIBILITIES OF MEASURING MAGNETIC FIELD STRENGTHS USING THIN-FILM HALL-E.M.F. PROBES PREPARED FROM HgSe, HgTe AND THEIR SOLID SOLUTIONS. O.D.Elpat'evskaya and A.R.Regel'.
Zh. tekh. Fiz., Vol. 26, No. 11, 2432-8 (1956). In Russian.

Evaporated films of HgSe have been found to have room temperature electron mobilities of up to 3000 $cm^2 V^{-1} sec^{-1}$ and carrier concentrations of $10^{17}$ to $10^{18}$ $cm^{-3}$. They can thus be used for magnetic field measurements, using the Hall effect, having sensitivities of the same order as single crystal Ge or InSb. Films deposited on mica, 1 cm wide, had sensitivities of 20 to 40 $\mu$V/gauss (or even 100 $\mu$V/gauss in extreme cases) at room temperature with no special cooling or heat dissipation arrangements. Advantages claimed are (1) suitability for use in small gaps, (2) flexibility, (3) absence of contact rectification, (4) simplicity of manufacture, (5) cheapness and ready availability of materials. J.B.Arthur

538.221

7212. THE FREQUENCY DEPENDENCE OF THE PERMEABILITY OF MAGNETITE BETWEEN 1 AND 3 kMc/s.
I.Nagy, D.Pallagi and L.Pál.
Acta phys. Hungar., Vol. 6, No. 2, 341-4 (1956).

Reports results of waveguide measurements on magnetite powders of size less than 10$\mu$ dispersed in paraffin wax. The permeability and loss angle are linear functions of volume concentration, and the real and imaginary components of the permeability vary with frequency in the usual way. E.P.Wohlfarth

538.221

7213. ANOMALOUS HYSTERESIS CYCLES DUE TO DIFFUSION MAGNETIC AFTER-EFFECT. P.Brissonneau.
C.R. Acad. Sci. (Paris), Vol. 244, No. 7, 868-70 (Feb. 11, 1957). In French.

Reports results of measurements of the hysteresis cycles of an Armco iron specimen containing a small amount of carbon, as dependent on the maximum applied a.c. field strength and the time interval between application and measurement. In some cases constricted loops were observed. E.P.Wohlfarth

538.221 : 539.217

7214. INVESTIGATION OF THE DIFFUSION OF CARBON IN IRON. P.Brissonneau.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1341-4 (March 4, 1957). In French.

Reports results of measurements at −21° to −34°C of the induction of a carbon-containing iron specimen as a function of field strength and time. The magnetic after-effect is marked, and values of the diffusion times and activation energies are deduced. See also Abstr. 382/1955. E.P.Wohlfarth

538.221

7215. FERRIMAGNETIC RESONANCE OF GADOLINIUM GARNET AT 9300 Mc/s. J.Paulevé.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1908-10 (April 1, 1957). In French.

Reports results of resonance measurements on $5Fe_2O_3.3Gd_2O_3$ between 4° and 700°K and estimates the values of the g factor from the temperature variation of the resonance field. Below the compensation temperature, 290°K, the results are masked by impurity effects. E.P.Wohlfarth

538.221

7216. MAGNETIC DIPOLE EFFECTS IN FERRITES.
R.A.Johnson and D.W.Healy, Jr.
J. chem. Phys., Vol. 26, No. 5, 1031-5 (May, 1957).

Presents an analysis of the role which classical magnetic dipole–dipole interections may play in the physical behaviour of ferrites with particular attention to magnetic anisotropy. Included is an evaluation of these effects in magnetite and lithium ferrite where an ordered arrangement of dipoles can exist and a study and calculation of some statistical effects which exist in other ferrites where this ordering is absent. The results obtained from this analysis are then compared with the pertinent experimental data. A.

538.221 : 548.736

7217. CATION DISTRIBUTION AND MAGNETIC MOMENT OF MANGANESE FERRITE.
F.W.Harrison, W.P.Osmond and R.W.Teale.
Phys. Rev., Vol. 106, No. 5, 865-6 (June 1, 1957).

It is shown that the value of the magnetic moment of manganese

ferrite measured recently by Hastings and Corliss (Abstr. 1761/1957) can be explained on the basis of their observations of cation distribution if the Mn in A and B sites is assumed to be $Mn^{2+}$ and $Mn^{3+}$, respectively. This possibility is discussed in relation to the ionic composition found for a single crystal of manganese ferrite grown by the flame fusion method. A.

538.221 : 536.631

7218. MOLECULAR FIELD FLUCTUATION EFFECTS IN MIXED NICKEL–ZINC FERRITES.
D.M.Grimes, S.Legvold and E.F.Westrum,Jr.
Phys. Rev., Vol. 106, No. 5, 866-7 (June 1, 1957).

The concept of molecular field fluctuations is utilized to discuss the thermal variation of the magnetic moment and the heat capacity of some mixed nickel–zinc ferrites. Experimental data on the magnetic moment are shown. It is concluded that for material with large molecular field fluctuations the concept of a single Curie temperature becomes meaningless. For the same reason, the absence of heat capacity evidence of triangular configuration transitions does not necessarily invalidate the theory for nickel–zinc ferrites. A.

538.221 : 539.319

7219. STRESS IN EVAPORATED FERROMAGNETIC FILMS.
J.R.Macdonald.
Phys. Rev., Vol. 106, No. 5, 890-2 (June 1, 1957).

Ferromagnetic resonance and oscillation magnetometer measurements on a thin evaporated nickel film annealed in a magnetic field are described. Observations of the dependence of the resonant field magnitude on the angle in the plane of the film between the direction of the magnetic field during annealing and the static resonance field direction show that magnetic annealing produced a preferred magnetic axis in the plane of the film. The good agreement between theory and experiment allows one to establish that the film had bulk-nickel g and saturation magnetization values, a large isotropic tension in the plane, and a lesser uniaxial compression in the plane in the direction of the preferred magnetic axis. In the light of these results, it is suggested that part of the discrepancy between theory and ferromagnetic resonance experiments found recently by Conger and Essig (Abstr. 2399/1957) for the dependence of saturation magnetization on evaporated film thickness may have arisen from their omission of stress corrections to the resonance condition. Further, part of the difference between film switching times derived from resonance line widths and those directly measured on the same films by these authors may have been caused by the narrowing of ferromagnetic line widths for thin films, as compared with bulk material, produced by the strong dependence on resonant absorption of power transmission entirely through sufficiently thin films. A.

538.221

7220. MAGNETIC PROPERTIES OF Cu–Mn ALLOYS. K.Yosida.
Phys. Rev., Vol. 106, No. 5, 893-8 (June 1, 1957).

The polarization of conduction electrons due to s-d interaction in CuMn alloys is investigated. The uniform polarization due to the first-order perturbed energy corresponding to the Fröhlich–Nabarro and Zener mechanism is shown to be completely modified by the first-order perturbation of the wave-functions and the polarization is concentrated in the neighbourhood of the Mn ions. At the same time it is shown that the Fröhlich–Nabarro interaction is included in the Ruderman–Kittel result as one component. The electronic g-value of Mn ions and the Knight shift of the Cu nuclei are also discussed from this point of view. A.

538.221.08 : 537.226.2.08

7221. TOWARDS THE THEORY OF THE MEASUREMENT OF $\mu$ AND $\epsilon$ OF SEMICONDUCTING FERROMAGNETICS.
K.M.Polivanov.
Dokl. Akad. Nauk SSSR, Vol. 95, No. 1, 61-4 (1954). In Russian.

A method of measuring the permeability $\mu$ and dielectric constant $\epsilon$ of ferrites is described. Specimens are fashioned into particular shapes and their open- and short-circuit impedances when used as terminations for a coaxial line are measured. Simple formulae are given for the calculation of $\mu$ and $\epsilon$. Several advantages over the method of Brockman, Dowling and Steneck (see Abstr. 3141/1950) are claimed. J.B.Arthur

538.222

7222. MAGNETIC PROPERTIES OF $MnAu_3$.
A.J.P.Meyer.
C.R. Acad. Sci. (Paris), Vol. 244, No. 15, 2028-31 (April 8, 1957). In French.

Reports results of measurements of the susceptibility between 90°K and room temperature, and in fields up to $2.7 \times 10^4$ oersted. A susceptibility maximum is observed at 145°K. E.P.Wohlfarth

538.222 : 539.185.9

7223. MAGNETIC SUSCEPTIBILITY OF NEUTRON-DAMAGED GRAPHITE. J.E.Hove and J.D.McClelland.
J. chem. Phys., Vol. 26, No. 5, 1028-30 (May, 1957).

Previous work on the magnetic susceptibility of graphite as it is affected by temperature and bromination is extended to include effects of neutron irradiation at about room temperature. Data taken at both room temperature and liquid nitrogen temperature are analysed and yield consistent values for the number of electrons trapped out by damage defects, thus further establishing the validity of the theory. The trapping rate of electrons, with neutron exposure, is found to be slightly nonlinear and a fair fit of the empirical curve is: Number of trapped electrons per carbon atom = $1.4 \times 10^{-4} t^{2/3}$, where t is the flux. This two-thirds power dependence cannot be taken too literally, since neither the quantity nor quality of the data is sufficiently good. Data are also given for the buildup of paramagnetic centres as damage increases. A.

538.222

7224. PARAMAGNETIC RESONANCE DETECTION ALONG THE POLARIZING FIELD DIRECTION. G.Whitfield and A.G.Redfield.
Phys. Rev., Vol. 106, No. 5, 918-20 (June 1, 1957).

Strong r.f. power, modulated at a low frequency, was applied to a paramagnetic solid (diphenyl pycril hydrazil) in a d.c. field $H_z$ of up to 20 gauss. The resulting changes in $M_z$ at the modulation frequency produced a voltage in a coil oriented in the z-direction, to provide a measure of $M_z$. A sensitive test of the equation of motion of the spin magnetization was achieved by using 19.5 Mc/s circularly polarized r.f. of up to 6 gauss in the x-y plane, square-wave modulated at 280 c/s. The observed 280 c/s signal was consistent with the Bloch equations, assuming relaxation toward the instantaneous applied magnetic field. As predicted, $M_z$ was not zero when $H_z = 0$. A Bloch–Seigert effect was also observed. A.

538.222

7225. THE MAGNETIC SUSCEPTIBILITIES OF LANTHANUM, CERIUM, PRASEODYMIUM, NEODYMIUM AND SAMARIUM, FROM 1.5°K TO 300°K. J.M.Lock.
Proc. Phys. Soc. B, Vol. 70, Pt 6, 566-76 (June, 1957).

The magnetic susceptibilities of these rare-earth metals have been measured over the temperature range 1.5°K to 300°K. Low temperature anomalies correlating with recent specific heat measurements have been found in cerium, neodymium and samarium at temperatures of 12.5°K, 7.5°K and 14.8°K respectively, and it is believed that these metals become anti-ferromagnetic below these temperatures. At higher temperatures the susceptibilities of cerium and praseodymium obey the Curie–Weiss law, with effective atomic moments of 2.51 and 3.56 Bohr magnetons respectively. Neodymium obeys a law of the form $\chi = C/(T - \theta) + K$, where the Curie constant C indicates an effective atomic moment of 3.3 Bohr magnetons ($\mu_B$) These moments are in fair agreement with the values expected for the trivalent ions of the elements, assuming Russell–Saunders coupling of the orbital and spin moments of the 4f electrons. A.

538.222 : 548.736.3

MAGNETIC PROPERTIES OF $TiFe_2O_5$–$Ti_2FeO_5$ SOLID SOLUTION. See Abstr. 6745

538.224 : 539.185.9

7226. MAGNETOCHROMATIC EFFECT INDUCED BY THERMAL NEUTRONS IN MAGNETICALLY PURE FUSED QUARTZ.
N.Perakis.
C.R. Acad. Sci. (Paris), Vol. 244, No. 5, 568-71 (Jan. 28, 1957). In French.

Reports results of susceptibility measurements on a normal specimen, whose susceptibility is constant ($-0.402 \times 10^{-6}$) over the temperature range 100°–900°K, and an irradiated specimen, whose susceptibility has a temperature dependent paramagnetic component due to the presence of colour centres. These disappear, and normal diamagnetism is recovered by heating above about 870°K.

E.P.Wohlfarth

538.24

7227. ON THE DETERMINATION OF THE TIME CONSTANTS OF MAGNETIC AFTER-EFFECT DUE TO DIFFUSION.
P.Brissonneau.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1174-7 (Feb. 25, 1957). In French.

Gives some experimental results on the spectrum of diffusion time constants for comparison with calculated curves.

A.E.De Barr

538.24 : 621.318.13

7228. MAGNETIC VISCOSITY IN 4-79 MOLYBDENUM PERMALLOY. O.J.Van Sant.
J. appl. Phys., Vol. 28, No. 4, 486-94 (April, 1957).

The dynamic behaviour of 4-79 molybdenum Permalloy operating in a reversible region of its hysteresis loop is analysed theoretically and experimentally. A useful expression is presented which relates B, H, time, and magnetic viscosity. This expression is applied to determine the behaviour of the magnetic material when magnetized (1) by sinusoidal currents having frequencies in the kilocycle/second region and (2) by step-function currents producing transient voltages with time constants in the millimicrosecond region. The theoretical results show that there is a correlation between the behaviours under these two extreme cases of current excitation. This correlation is verified by measurements made on thin tapes having nominal thicknesses of $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{3}$, and $\frac{1}{2}$ mil and the results of these measurements agree with theory. Various effects of magnetic viscosity on the dynamic behaviour of the core material are shown and an expression is derived which makes it possible to solve theoretically certain kinds of magnetic engineering problems whose theoretical solutions have not been achieved previously. These problems pertain to devices such as shift registers, high-frequency transformers, and high-frequency magnetic amplifiers which contain cores made of thin ferromagnetic tape. A.

538.244.2 : 621.318.381

7229. SOME MEASUREMENTS OF THE MAGNETIC FIELD PRODUCED BY RIDGED POLE PIECES. P.F.Smith.
Atomic Energy Res. Establ. (Harwell) Mem. GP/M195, 6 pp. (1956).

Some measurements have been made of the field distribution arising from straight, parallel, ridges of rectangular cross-section on the poles of a magnet. The quantities "mean gap" and "magnetic field flutter" are defined, and are tabulated for 14 systems of ridges, at mean fields between 8 kG and 20 kG. This account is confined to the cases in which the ridge width is half the distance between successive ridges. Some theoretical calculations are compared with the experimental results, and some preliminary measurements on sector-shaped ridges are also described. A.

538.245 : 539.219

7230. ORIENTATION OF COBALT PRECIPITATES IN CuCo ALLOYS. L.Weil, L.Gruner and A.Deschamps.
C.R. Acad. Sci. (Paris), Vol. 244, No. 16, 2143-6 (April 5, 1957). In French.

Reports results of low temperature measurements of the saturation magnetization, the remanent magnetization and the coercive force of CuCo alloys containing small (~ 60 A ) single domain cubic cobalt precipitates. The precipitates are shown to be partially oriented, due either to shape anisotropy or to an epitaxy of the precipitation in copper. E.P.Wohlfarth

538.245 : 537.312.5

7231. OBSERVATION OF THE DOMAIN STRUCTURE OF A FERROMAGNETIC USING PHOTOELECTRONS.
G V.Spivak, T.N.Dombrovskaya and N.N.Sedov.
Dokl. Akad. Nauk SSSR, Vol. 113, No. 1, 78-81 (1957). In Russian.

The apparatus consists of a glass model of the emission microscope with continuous evacuation. The source of photoelectrons in the microscope is a Sb–Cs cathode layer on the specimen of ferromagnetic being studied. Round the outside of the tube at this point is the coil of the cathode electron lens. Emission of photoelectrons is caused by directing the beam from an electric lamp on to the specimen. The direction in which the electrons move off is governed by the interaction of the cathode electron lens field and the microfields of the domain structure of the specimen.

C.R.S.Manders

538.245 : 539.232 : 621.318.12

7232. LOW FREQUENCY DISPERSION OF $\rho$ AND $\epsilon$ IN FERRITES. J.P.Suchet.
Proc. Inst. Radio Engrs, Vol. 45, No. 3, 360 (March, 1957).

Uses some data of Koops (Abstr. 6964/1051) to calculate the thickness of the superficial layer of NiZn ferrites. Values of 1-5 A for fast cooling, and 20-32 A for slow cooling are obtained, and are interpreted in terms of two different oxidation mechanisms.

A.E.De Barr

538.245 : 621.318.12

7233. ORDERING IN COBALT-FERROUS FERRITES.
H.P.J.Wijn, H.van der Heide and J.F.Fast.
Proc. Instn Elect. Engrs, Paper 2322R, publ. 1957 (Part B Suppl. No. 7, 412-17, 433-5).

Various cobalt–ferrous ferrites show a constricted hysteresis loop. After magnetic annealing of the samples the loop becomes rectangular. It appears that the magnetic annealing creates in each crystal a uniaxial anisotropy in a direction which is not necessarily the direction of the applied magnetic field but a crystallographic direction nearest to it. It is suggested that directional ordering is the most probable origin of the anisotropy found. A.

# ELECTROMAGNETISM. ELECTRODYNAMICS 538.3/.5

538.3 : 532.5

7234. SOLUTION OF FLOW PROBLEMS IN UNIDIMENSIONAL LAGRANGIAN HYDROMAGNETICS. R.E.Loughhead.
Austral. J. Phys., Vol. 10, No. 1, 213-16 (March, 1957).

Unidimensional flow of an ionized gas is considered. The subsequent behaviour of a current initially concentrated in a given region is studied. In the case considered the equations of motion are amenable to numerical treatment, and the amount of numerical work involved is reduced by taking the equations in Lagrangian rather than the usual Eulerian form. The problem considered is of considerable interest in astrophysics (see Abstr. 2309/1951). For previous work see Abstr. 108 (1956). L.S.Goddard

538.3 : 532.5

7235. SOME ASPECTS OF MAGNETOHYDRODYNAMICS. G.H.A.Cole.
Advances in Phys., Vol. 5, 452-97 (Oct., 1956).

In this detailed survey of recent developments, the hydromagnetic equations are derived and solutions are obtained for waves in incompressible and in compressible media; magnetothermal effects are discussed with particular reference to thermal instability, and recent work on shock propagation and structure is reviewed. The possibility of the confirmation of theoretical results by laboratory demonstrations and astrophysical observations is also briefly considered. R.A.Newing

538.3

7236. ON THE SOLUTION OF MAXWELL'S EQUATIONS IN CYLINDRICAL COORDINATES BY MEANS OF THE LAPLACE TRANSFORM AND THE FINITE FOURIER AND HANKEL TRANSFORMS. H.Delavault.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1146-9 (Feb. 25, 1957). In French.

The solutions are obtained in gernal form and applied in an example where the expressions for the field components involve a Fourier–Bessel series. L.S.Goddard

# ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

7237. ON THE EXISTENCE AND CONSERVATION OF REACTIVE POWER IN RADIANT PHENOMENA. C.Budeanu.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1171-4 (Feb. 25, 1957). In French.

Equations expressing the conservation of power are obtained from Maxwell's equations. The complex Poynting vector is used in a region containing not only passive points but also excited regions characterized by the existence of a vector field. L.S.Goddard

538.56 : 532.5

7238. OSCILLATIONS OF A CYLINDRICAL PLASMA. T.H.Stix.
Phys. Rev., Vol. 106, No. 6, 1146-50 (June 15, 1957).

The natural modes of oscillation of a cylindrical plasma of finite density at zero pressure in a longitudinal magnetic field are examined. When one considers frequencies well below the electron plasma and electron cyleotron frequencies, there appear in two limiting cases hydromagnetic waves, and waves whose natural frequencies are close to the ion cyclotron frequency. This cyclotron frequency resonance occurs when the wavelength of the oscillation in the z-direction is short compared to the wavelength for light in vacuo corresponding to the root square sum of the ion plasma frequency and the ion cyclotron frequency. A.

538.561 : 537.523.3 : 621.373.1

7239. A RELAXATION OSCILLATION MAINTAINED BY DISCHARGE CORONA. M.I.Large.
Nature (London), Vol. 179, 707-8 (April 6, 1957).

With a point—plane arrangement of either polarity, the needle often oscillated mechanically near its natural frequency with the discharge current and Trichel pulse frequency, producing a note twice this frequency as monitored by a receiver. The device makes a simple frequency-modulated signal generator. The action is explained and the principle made use of in two further demonstrations. A.E.D.Heylen

538.561 : 621.375

7240. INHERENT NOISE OF QUANTUM-MECHANICAL AMPLIFIERS. M.W.P.Strandberg.
Phys. Rev., Vol. 106, No. 4, 617-20 (May 15, 1957).

The noise figure of limiting sensitivity for both travelling-wave and resonant-cavity quantum-mechanical amplifiers, sensitive to one direction of propagation is derived with spontaneous emission as the limiting noise. The concept of effective temperature is introduced as an analytical parameter; thus negative temperatures appear in a natural fashion. It is pointed out that the results of this calculation can be considered the solution to the problem of linear counting of coherent particles. In this case the least count is one and the signal-to-noise ratio (for constant photon flux) increases as the reciprocal of the bandwidth. The limiting temperature sensitivity of properly designed quantum-mechanical amplifiers is given as $h\nu/k$ degrees because of the drastic difference between negative and positive temperatures. A.

538.561 : 537.312.5 : 621.383.27

7241. ON GENERATION IN PHOTOELEMENTS AND PHOTOMULTIPLIERS. P.V.Makovetskiĭ.
Zh. tekh. Fiz., Vol. 26, No. 12, 2652-60 (1956). In Russian.

Describes the observation of oscillations in the output of a particular type of photomultiplier. They occur at certain combinations of illumination intensity and accelerating voltage; they are stable and practically self-maintaining and their frequencies are determined by the time constant associated with each dynode. The effect has many features in common with the oscillation observed in photoelements by Vaĭnshteĭn and Malyavkin (Zh. tekh. Fiz., Vol. 22, 1315, 1952). The distribution of accelerating voltage between the fourteen dynodes was measured and it was found that generation occurred when a decrease in voltage on one stage was accompanied by an increase in that on the next stage. At such a point, the effective coefficient of secondary emission drops below unity. J.B.Arthur

538.565 : 621.372.413

7242. QUANTUM EFFECTS IN THE INTERACTION OF ELECTRONS WITH HIGH-FREQUENCY FIELDS IN CAVITY RESONATORS. V.L.Ginzburg and V.M.Faĭn.
Zh. éksper. teor. Fiz., Vol. 32, No. 1, 162-4 (1957). In Russian.

A short discussion is presented of the problem of dispersion of kinetic energy of electrons passing through a resonator. Considering non-relativistic electrons, an expression for the dispersion of kinetic energy is derived using the generalized Nyquist relation for linear dissipative systems. Z.Krasucki

538.566

7243. BACKSCATTERING FROM DIELECTRIC-COATED INFINITE CYLINDRICAL OBSTACLES. C.C.H.Tang.
J. appl. Phys., Vol. 28, No. 5, 628-33 (May, 1957).

The electromagnetic backscattering properties of an infinite conducting cylinder coated with a lossless dielectric layer of thickness comparable to a wavelength is investigated both theoretically and experimentally. The theoretical problem is first formulated with three regions of arbitrary constants and then reduced to the specific cases. The experimental investigation utilizes the parallel-plate-region technique modified to permit the application of the Doppler shift principle. The scattering obstacle is set in motion in the presence of a plane-wave electromagnetic field in the parallel-plate region, and the detected Doppler signal is directly proportional to the backscattered field of the obstacle in question. The theoretical and experimental results are in excellent agreement. A.

538.566 : 621.372.8

7244. TRANSVERSE-MAGNETIC SURFACE WAVE ON AN INFINITELY CONDUCTING CYLINDER. C.Jauquet.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 43, No. 11, 1178-83 (1956). In French.

A particular solution demonstrates the existence of axially symmetric transverse-magnetic waves guided by the cylinder, and it is concluded electrical loss in the guide is not a necessary condition for the existence of surface waves. R.A.Newing

538.566 : 621.372.823

7245. ORTHOGONALITY RELATION FOR GYROTROPIC WAVE GUIDES. L.R.Walker.
J. appl. Phys., Vol. 28, No. 3, 377 (March, 1957).

Orthogonality formulae for cylindrical waveguides are generalized to cases in which permeability and dielectric constant are represented by Hermitian matrices. The results are applicable to guides partially filled with ferrite or plasma. A.J.Egginton

538.566 : 523.164

AERIAL SMOOTHING IN RADIO ASTRONOMY. See Abstr. 6822

538.566 : 531.715 : 621.396.962.25

RADAR INTERFEROMETRY IN DISTANCE MEASUREMENT. See Abstr. 6923

538.566.3 : 621.396.11

7246. MEASUREMENT OF IONOSPHERIC PATH-PHASE FOR OBLIQUE INCIDENCE. R.Price and P.E.Green,Jr.
Nature (London), Vol. 179, 372-3 (Feb. 16, 1957).

Brief description of three techniques for direct measurement of changes of carrier phase at oblique incidence, employing 160 μsec radio-pulses having a highly stable carrier frequency and repetition rate. The undetected wave-train received is heterodyned with an i.f. which is an integral multiple of the repetition rate, and different devices are used for oscilloscope display. Sample records for each technique are given. G.M.Brown

538.566.3

7247. OBLIQUE RAY PATHS IN THE IONOSPHERE. J.Haselgrove.
Proc. Phys. Soc. B, Vol. 70, Pt 7, 653-62 (July, 1957).

An electronic digital computer has been used to calculate ray paths in a parabolic ionospheric layer when the waves are incident in the plane of the magnetic meridian. This is a special application of a very general method. The results of the calculations are compared with what would be deduced from vertical soundings by the standard approximations of using Martyn's and Breit and Tuve's theorems as if there were no field. A.

# MOLECULAR AND ATOMIC STRUCTURE

## 539.1

# THEORY OF SOLID STATE 539.11

539.11 : 537.311.31

7248. ON THE CONNECTION BETWEEN ELECTRICAL RESISTIVITY AND POTENTIAL ENERGY IN PURE METALS. G.Borelius.
Ark. Fys., Vol. 11, Paper 20, 291-5 (1956).

Considerations similar to those of Abstr. 4779/1953, 1239/1954, and 1153/1956, on the connection between potential energy and lattice disorder, suggest plotting resistance r against U, the potential part of the thermal energy. This is done for eight cubic metals; the plots start approximately linearly from T = 0, then bend and become asymptotic for $T > 1.5\ \Theta_D$ to another line, $r \propto (U + U_z)$, where $U_z$ is interpreted as the potential part of the zero-point energy. This suggests that though the zero-point energy gives no contribution to r at T = 0, it does contribute at higher T. J.Hawgood

539.11 : 536.75 : 536.421.1

7249. ON THE ENTROPY OF SOLID AND LIQUID METALS. G.Borelius.
Ark. Fys., Vol. 11, Paper 34, 421-7 (1957).

Diagrams of the potential part of the entropy plotted against volume give similar impressions to those of potential energy against volume, namely, that a smooth plot can be made from solid to liquid for f.c.c. but not b.c.c. metals, suggesting that fusion involves a structural change for the latter but not the former. A "change in volume due to zero-point energy" can be derived from the plots, in a way analogous to the derivation of $U_z$ (see preceding abstract). J.Hawgood

539.11

7250. CONTRIBUTION OF CORE POLARIZATION TO THE COHESIVE ENERGIES OF THE ALKALI METALS. J.Callaway.
Phys. Rev., Vol. 106, No. 5, 868-74 (June 1, 1957).

An approximate potential is constructed to represent the effect of polarization of the atomic core on the energy of the valence electron in an atom with one valence electron. The potential is proportional to $1/R^4$ at large distances from the nucleus, but vanishes at the origin. The potential is treated in first-order perturbation theory to determine its contribution to the cohesive energies of the alkali metals. Numerical calculations have been made for lithium, sodium, and potassium. In the latter element, it represents about one third of the observed cohesive energy. A.

539.11

7251. ADDENDUM TO THE PAPER "CALCULATION OF THE INTERATOMIC DISTANCE AT WHICH A MODEL OF COMPRESSED SOLID HELIUM BECOMES A METAL". C.A.ten Seldam.
Proc. Phys. Soc. A, Vol. 70, Pt 7, 529-31 (July, 1957).
See Abstr. 4576 (1957).

539.11 : 537.533.75

ELECTRON BOMBARDMENT STUDY OF ENERGY BANDS IN KCl. See Abstr. 7155

## MOLECULES 539.13

539.132

7252. THE SEPARATION OF THE MOTION OF ELECTRONS AND NUCLEI. R.Daudel and S.Bratož.
Cahiers de Phys., No. 75-6, 39-48 (Nov.-Dec., 1956). In French.

A re-examination of the limits of validity of the Born–Oppenheimer theorem. The limitations are important in the calculation of vibrational transitions especially of intensities of absorption bands in the infrared. The theorem is valid only when the nuclei are near the equilibrium position. Methods of extending the validity of the theorem are discussed. R.C.Seymour

539.132 : 535.343

7253. A MATRIX METHOD FOR THE COUPLING OF COMPONENTS IN MOLECULAR SPECTROSCOPY. F.Roger.
Cahiers de Phys., No. 75-6, 69-70 (Nov.-Dec., 1956). In French.

A treatment based upon Heisenberg's matrix mechanics permits determination of the coupling between groups contributing to absorption and leads to results in agreement with experiment e.g. for p-polyphenyls and alkyl substituted ethylenes. R.C.Seymour

539.132

7254. POPULATION OF THE VIBRATIONAL LEVELS OF THE ELECTRONIC STATE $B^2\Sigma^+$ OF THE MOLECULE CN EXCITED IN PRESENCE OF ACTIVE NITROGEN. J.Akriche and L.Herman.
C.R. Acad. Sci. (Paris), Vol. 244, No. 8, 1024-6 (Feb. 18, 1957). In French.

Intensity measurements are combined with transition probabilities to derive the following relative populations:

| v | : | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| N(v) | : | 76 | 38 | 25 | 32 | 28 | 31 | 20 |

Excitation processes are considered briefly. R.F.Barrow

539.132

7255. RESTORING FIELD AND DISPLACEMENT OF VIBRATION FREQUENCY OF A POLAR MOLECULE IN A NON-POLAR MEDIUM. L.Galatry and F.G.Schuller.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1749-51 (March 25, 1957). In French.

The usual calculation of the restoring field of a polar molecule at the centre of a cavity in a homogeneous dielectric is enlarged to take account of the discontinuous structure of the dielectric. This is applied to displacement of the vibration frequency of HCl. R.W.Nicholls

539.132

7256. MOLECULAR VIBRATIONS AND FORCE CONSTANTS. P.Barchewitz.
Cahiers de Phys., No. 75-76, 1-10 (Nov.-Dec., 1956). In French.

A review of the classical and wave-mechanical calculation of vibration frequencies and force constants. R.C.Seymour

539.132

7257. CALCULATION OF THE INTENSITY OF VIBRATION–ROTATION LINES (DIATOMIC MOLECULES). F.Legay.
Cahiers de Phys., No. 75-76, 11-16 (Nov.-Dec., 1956). In French.

The methods for calculating line intensities in the vibration–rotation bands of diatomic molecules are discussed. R.C.Seymour

539.132

7258. EFFECT OF SUBSTITUENTS ON THE VIBRATION OF C=O IN P-QUINONES. INTERPRETATION BY L.C.A.O. MOLECULAR ORBITALS. J.Deschamps, M.Paty and M.L.Josien.
Cahiers de Phys., No. 75-6, 70-2 (Nov.-Dec., 1956). In French.

Using a relation due to Coulson and Longuet-Higgins for the force constant of a bond, the shift in frequency of a group (e.g. C=O) on substitution, may be calculated from the calculated variation in bond order. For substituted p-benzoquinones and 1.4 naphthaquinones the experimental data fit the equation $\Delta\nu_{C=O} = C_1\Delta p_{C=O}$, where $C_1$ is a constant and $\Delta p_{C=O}$ the change in bond order on substitution. R.C.Seymour

539.132

7259. ANOMALOUS CENTRIFUGAL DISTORTION COEFFICIENTS IN LINEAR POLYATOMIC MOLECULES.
H.H.Nielsen, G.Amat and M.Goldsmith.
J. chem. Phys., Vol. 26, No. 5, 1060-6 (May, 1957).

The theory of the effect of resonance, in particular Fermi resonance and l-type resonance, on the effective centrifugal distortion coefficient of a molecule for a given vibration state is developed. The theory is applied to certain cases where l-type resonance occurs and to certain cases where both l-type resonance and Fermi resonance occur. No instances appear to have been investigated where Fermi resonance occurs without l-type resonance being present. The agreement between the theory and the experimental results appears to be satisfactory to the approximation of the theory. A.

539.132 : 535.343

7260. VIBRATIONAL SPECTRUM OF DISILANE.
G.W.Bethke and M.K.Wilson.
J. chem. Phys., Vol. 26, No. 5, 1107-17 (May, 1957).

Raman spectra of the liquid and infrared spectra of the gaseous phase have been obtained for $Si_2H_6$ and $Si_2D_6$. With the exception of the torsional mode all fundamental frequencies have been observed and assigned to the proper normal modes. The coarse rotational structure of the perpendicular bands, $\nu_8$ and $\nu_9$, has been resolved and the corresponding Coriolis coupling coefficients determined. Comparisons with the spectra of ethane and digermane have been made. A.

539.132 : 535.343

7261. VIBRATIONAL SPECTRUM OF BORINE CARBONYL.
G.W.Bethke and M.K.Wilson.
J. chem. Phys., Vol. 26, No. 5, 1118-30 (May, 1957).

The infrared spectra of both solid and gaseous $BH_3CO$, $B^{10}H_3CO$, $BD_3CO$, and $B^{10}D_3CO$ have been obtained. In addition some observations have been made on the Raman spectra of the gaseous compounds. Fundamental frequencies have been assigned to all normal modes and the vibrational potential constants for borine carbonyl have been approximated by means of a simplified force field. A.

539.13

7262. NORMAL FREQUENCIES OF TETRAHEDRAL $M(XY)_4$ MOLECULES. H.Murata and K.Kawai.
J. chem. Phys., Vol. 26, No. 5, 1355-6 (May, 1957).

Theoretical. General expressions for the F and G matrix elements are given, and used to calculate the vibrational spectrum of $Ni(CO)_4$, giving good agreement with experiment. J.Hawgood

539.132 : 535.34

7263. INTENSITIES IN INORGANIC COMPLEXES.
A.D.Liehr and C.J.Ballhausen.
Phys. Rev., Vol. 106, No. 6, 1161-3 (June 15, 1957).

A method for calculating the intensity of $d^n$ electronic transitions in inorganic complexes is developed and subsequently applied to the computation of the intensity of the visible absorption bands of Ti(III) and Cu(II) complexes. The observed and calculated oscillator strengths are in good agreement. A.

539.13

7264. CONFIGURATIONAL INSTABILITY OF DEGENERATE ELECTRONIC STATES. W.Moffitt and A.D.Liehr.
Phys. Rev., Vol. 106, No. 6, 1195-200 (June 15, 1957).

The implications of the Jahn–Teller theorem are discussed

with special reference to the case where the forces tending to lower the symmetry of electronically degenerate molecular states are of the same order as the restoring forces encountered during typical vibrations. It is shown that the resulting dynamical situation may be described as a particular kind of coupling between low-frequency electronic motions and nuclear modes. A.

539.132

7265. PROPERTIES OF THE HYDROGEN MOLECULAR ION. VII. MAGNETIC DIPOLE OSCILLATOR STRENGTHS OF THE $1s\sigma_g - 3d\pi_g$ TRANSITION. A.Dalgarno and R.McCarroll.
Proc. Phys. Soc. A, Vol. 70, Pt 7, 501-6 (July, 1957).

See Abstr. 8126 (1955) and 580 (1957). The magnetic dipole oscillator strengths of the $1s\sigma_g - 3d\pi_g$ transition of $H_2^+$ are computed over a wide range of nuclear separations from the exact two-centre wave-functions. A brief discussion is given of some related quantities and reasons are presented for supposing that the average values of the energy separations in second-order expressions involving magnetic quantities are larger than for the analogous electric quantities. A.

539.132

7266. FREE-ELECTRON RING MODEL OF POLYACENES. G.Araki.
Progr. theor. Phys., Vol. 16, No. 4, 265-8 (Oct., 1956).

Electronic energy levels of polyacenes are calculated by assuming their $\pi$-electrons to move freely in a ring of a circumference which is equal to the perimeter length of the polyacene molecule. The interaction between $\pi$-electrons is assumed to be the long-range part of the Coulomb interaction. The short-range part is omitted by the zero cut-off at 0.48 l of the arc length, where l is the distance between adjacent carbons in the molecule. The agreement between calculated and observed levels is fairly good. A.

539.132 : 538.612

7267. THE PARAMAGNETIC COTTON–MOUTON EFFECT IN DIPHENYL–PICRYL–HYDRAZYL AT MICROWAVES. P.Hedvig.
Acta phys. Hungar., Vol. 6, No. 3-4, 489-94 (1957).

Investigates the absorption of diphenyl picryl hydrazyl electron resonance as a function of field orientation and position in microwave cavity. A ring sample in longitudinal microwave magnetic field H gives a double peak. For microwave fields at 45° to the static field a rotation of the plane of polarization of a $TE_{112}$ cavity is observed. The effects are in agreement with the Bloch model. D.H.Whiffen

539.132

7268. THE DIRECT MEASUREMENT OF THE CHARACTERISTIC MOMENTS OF THE LINE STRUCTURE IN PARAMAGNETIC RESONANCE: MEASUREMENT ON THE "WINGS" OF THE DISPERSION CURVE. J.Hervé.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1182-5 (Feb. 25, 1957).
In French.

Gives the theory for obtaining the moments of an absorption curve from measurements in the "wings" of the dispersion curve using the Kramers–Kronig formulae; a discussion on accuracy is included. D.H.Whiffen

539.132

7269. THE DIRECT MEASUREMENT OF THE CHARACTERISTIC MOMENTS OF THE LINE STRUCTURE IN PARAMAGNETIC RESONANCE: SINUSOIDAL MODULATION AND HARMONIC ANALYSIS OF THE SIGNAL. J.Hervé.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1475-8 (March 11, 1957).
In French.

Gives the theory for determining the moments of an absorption curve from the Fourier decomposition of the signal obtained with modulation through the line and that obtained with a commutator to reverse the sign of the negative half cycles. For small modulations less than the signal width the curve may be decomposed into segments and the results finally compounded together. D.H.Whiffen

539.132

7270. THE OSCILLATOR STRENGTHS OF THE $1s\sigma - 2p\pi$, $2p\pi - 2s\sigma$ AND $2p\pi - 3d\sigma$ TRANSITIONS OF $HeH^{2+}$. A.M.Arthurs and J.Hyslop.
Proc. Phys. Soc. A, Vol. 70, Pt 7, 489-93 (July, 1957).

The oscillator strengths of the $1s\sigma - 2p\pi$, $2p\pi - 2s\sigma$ and $2p\pi - 3d\sigma$ transitions of $HeH^{2+}$ are calculated from the exact two-centre wave-functions. A comparison is made with results obtained from the LCAO approximation with and without mixing, both the dipole length and dipole velocity formulae being used in each case. A.

539.132

7271. PROTON SPIN–LATTICE RELAXATION IN MESITYLENE. C.A.Reilly and R.L.Strombotne.
J. chem. Phys., Vol. 26, No. 5, 1338-9 (May, 1957).

Spin–lattice relaxation times, $T_1$, are measured for the aromatic and aliphatic protons in mesitylene and extrapolated to zero concentration in $CS_2$. The total $(1/T_1)$ is split into inter- and intramolecular parts and the latter correlated with the aromatic–aliphatic proton–proton distance giving 2.64 A compared to the average distance of 2.81 A. D.H.Whiffen

539.132

7272. QUADRUPOLE RELAXATION AND STRUCTURES IN NITROGEN MAGNETIC RESONANCES OF AMMONIA AND AMMONIUM SALTS. R.A.Ogg, Jr and J.D.Ray.
J. chem. Phys., Vol. 26, No. 5, 1339-40 (May, 1957).

Quadrupole resonance of $N^{14}$ may give rise to broad $N^{14}$ resonances in the n.m.r. spectra at 3 Mc/s as observed in $(CH_3)_2NH_2^+$ and $(CH_3)_3NH^+$, but narrow lines are obtained with $NH_4^+$ and $(CH_3)_4N^+$ in which field asymmetry at the N must be absent. D.H.Whiffen

539.132

7273. QUADRUPOLE RELAXATION BROADENING OF THE MAGNETIC RESONANCE SPECTRUM OF METHYLAMMONIUM ION. R.A.Ogg, Jr and J.D.Ray.
J. chem. Phys., Vol. 26, No. 5, 1340-1 (May, 1957).

High-resolution proton resonance spectrum of $CH_3N^{15}H_3^+$ in $H_2O$ shows narrow lines in the expected intensity ratios and positions and this indicates that the broad lines found with $N^{14}$ arise from quadrupole relaxation. D.H.Whiffen

539.132

7274. ELECTRONIC STATES OF PARA-BENZOQUINONE. II. CALCULATION OF THE ENERGY LEVELS BY A SEMI-EMPIRICAL MOLECULAR ORBITAL METHOD INCLUDING CONFIGURATION INTERACTION. T.Anno, A.Sadô and I.Matabura.
J. chem. Phys., Vol. 26, No. 4, 967-8 (April, 1957).

Approximate calculation of the effects of limited configuration interaction on the singlet levels calculated in Pt I (Bulletin of the Chemical Society of Japan, Vol. 30, No. 2, 1957) by Pariser–Parr method. Agreement with experiment is improved, particularly if the 4.25 eV band is re-assigned as an $n-\pi$ transition. Change of $\beta_{CC}$ by 10% has little effect. J.Hawgood

539.132

7275. TWO-CENTER DIPOLE MOMENT INTEGRALS IN TERMS OF C FUNCTIONS. W.C.Hamilton.
J. chem. Phys., Vol. 26, No. 5, 1018-20 (May, 1957).

The dipole moment integrals for Slater-type atomic orbitals are conveniently and concisely expressed in terms of the C functions introduced by Ruedenberg, Roothaan, and Jaunzemis in their treatment of the two-centre hybrid integrals. Explicit formula in terms of both the C functions and the usual A and B functions are given for all such integrals involving orbitals with quantum numbers one and two. A.

539.132

7276. USE OF GAUSSIAN WAVE FUNCTIONS IN MOLECULAR CALCULATIONS. G.E.Kimball and G.F.Neumark.
J. chem. Phys., Vol. 26, No. 5, 1285-7 (May, 1957).

Gaussian functions have been used in a simple variational approach to calculate the energy of a number of two-electron systems, namely the hydrogen molecule, the negatively charged hydrogen ion, and the $(1s)^2\ ^1S$, $(1s)(2s)\ ^3S$, and $(1s)(2p)\ ^3P$ states of helium. The last two were included in order to test two different 2s and a 2p function. The error in the total energies varied from 14% to 33%, showing that these functions can give "fairly good" energy values. This, and some other evidence, seems to indicate that in such variational calculations the specific form of the starting wave-function may not be too important. Calculations were also carried out on one single electron system in order to further compare the two different 2s functions. Both here and in the case of the triplet helium both functions gave almost identical energies. A.

539.132

7277. APPROXIMATE MOLECULAR ORBITALS. VI. THE $2p\sigma$ STATE OF $HeH^{2+}$. R.McCarroll and B.L.Moiseiwitsch.
Proc. Phys. Soc. A, Vol. 70, Pt 7, 507-11 (July, 1957).

For Pt V see Abstr. 7587 (1956). Approximate wave-functions for the $2p\sigma$-state of the $HeH^{2+}$ molecular ion are obtained by the variational method. The values of the electronic total energies and potential energies computed using the approximate wave-functions

are compared with the exact values of these quantities. Exact values of the dipole moment are also obtained. A.

539.132

7278. CALCULATION OF THE MAGNETIC SUSCEPTIBILITY OF THE MOLECULE OF NITROGEN AND OF THE NITRILES.
J.Baudet, J.Tillieu and J.Guy.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1756-9 (March 25, 1957). In French.

The magnetic susceptibility of the nitrogen molecule is deduced by consideration of the contribution of the individual electronic orbits. Three different groups of constants give $\chi_M$ values of −14.61, −13.79 and −11.60. Theoretical $\chi_M$ values for acetonitrile, propionitrile, butyronitrile, and isoamyl cyanide are compared with experimental results and with values deduced from Pascal's constants. G.I.W.Llewelyn

539.133

7279. DIPOLE MOMENT OF LITHIUM HYDRIDE.
R.P.Hurst, J.Miller and F.A.Matsen.
J. chem. Phys., Vol. 26, No. 5, 1092-3 (May, 1957).

A dipole moment of 6.04 D, with hydrogen negative, has been computed for the LiH molecule, Electronegativity scales, X-ray crystal studies, and electrolysis of LiH give indirect support for this result. A.

539.133 : 535.343

STRUCTURE OF FORMIC ACID. See Abstr. 7010

539.133 : 535.343

STRUCTURE OF PROPIONITRILE. See Abstr. 7009

539.133

7280. A NEW ELECTRONIC CONCEPT OF THE DOUBLE BOND.
L.Singh.
Naturwissenschaften, Vol. 43, No. 20, 466 (1956).

It is postulated that the $\pi$-bond is bent, being formed by coupling p AO's at an angle, and is fixed in the molecule, not being free to rotate either through or about the $\sigma$-bond. It is claimed that this can explain magnetic and bond-length anomalies. J.Hawgood

539.133

7281. A NEW ELECTRONIC CONCEPT OF THE AROMATIC BOND. L.Singh.
Naturwissenschaften, Vol. 43, No. 21, 493-4 (1956).

The concept introduced earlier (see preceding abstract) is applied to benzene, leading to a model of "puckered" MO's, in which $\pi$-electrons move round the ring, alternately above and beneath it, three in each direction. It is claimed that this explains the stability and some magnetic properties of benzene. J.Hawgood

# ATOMS. NUCLEUS. ISOTOPES 539.15

539.152 : 539.18

7282. MESOATOMS. D.D.Ivanenko and G.E.Pustovalov.
Uspekhi fiz. Nauk, Vol. 61, No. 1, 27-43 (1957). In Russian.

A survey article (65 references) covering the experimental study of mesoatoms, calculation of the volume of the nucleus, the polarization of vacuum in mesoatoms (two useful tables of relative energy changes for $2P \rightarrow 1S$ transitions with $\pi$- and $\mu$-mesoatoms for $Z \leq 10$), the interaction of a $\pi$-meson with the nucleons of a nucleus. C.R.S.Manders

539.152.1

7283. MANY-BODY FORCES AND THE MANY-BODY PROBLEM.
J.C.Polkinghorne.
Nuclear Physics, Vol. 3, No. 1, 94-6 (March, 1957).

It is shown that, to a good approximation, many-body forces may be taken into account by the definition of an equivalent two-body force for use in shell model calculations of energy levels. A.

539.152.1

7284. ON THE DIFFERENCE BETWEEN THE DENSITY DISTRIBUTIONS OF NEUTRONS AND PROTONS IN THE NUCLEAR jj-COUPLING SHELL MODEL. G.Györgyi and E.Rupp.
Acta phys. Hungar., Vol. 6, No. 3-4, 495-7 (1957).

Following Mittelstaedt's arguments, different collective nuclear potentials on a phenomenological basis have been used to ensure approximately the $\beta$-stability of the nucleus discussed. The mesic charge of the neutrons was chosen as $g_n = 3.4$ e, that of the protons, $g_p = 3.8$ e, thus reducing the binding-energy difference between the last neutron and proton of $Gd^{160}$ to 3.65 MeV. The wave- and density-functions of all the $Gd^{160}$ nucleons have been determined, and they satisfy the constant density assumed in the zero-order approximation. The equivalent radii for the density distributions of the nucleons are: $Rp = 1.34 \times 10^{-13} A^{1/3}$ cm and $Rn = 1.40 \times 10^{-13} A^{1/3}$ cm. Calculations of these radii by other workers are discussed. J.J.Phipps

539.152.1

7285. ON MAGNETIC AND QUADRUPOLE MOMENTS AND ELECTROMAGNETIC TRANSITIONS IN THE COLLECTIVE MODEL.
J.Yoccoz.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1484-6 (March 11, 1957). In French.

The model is treated in a new way (Abstr. 1497/1957), by means of which, though the general formulae are the same, it is possible to evaluate the gyromagnetic factor. Results of some calculations are discussed. L.Pincherle

539.152.1

7286. STUDIES IN THE $\alpha$-PARTICLE MODEL OF NUCLEI. III. CALCULATION OF THE INTERACTION BETWEEN $\alpha$-PARTICLES. A.Herzenberg.
Nuclear Physics, Vol. 3, No. 1, 1-34 (March, 1957).

For Pt II, see Abstr. 7281 (1955). The interaction between $\alpha$-particles is investigated and compared with the requirements of the $\alpha$-particle model. These are that there should be a short-ranged repulsion to prevent the $\alpha$-particles from overlapping, and an additive attractive force reaching beyond the repulsion. The interaction energy is divided into four components of different origin and properties. These components are a direct interaction ($V_D$), which is analogous to the Coulomb interaction between ions and which exists only if the nuclear potential has a direct (i.e. non-exchange) tail, a nucleon-exchange interaction ($V_X$), a polarization interaction ($V_{POL}$), and the Coulomb interaction $E_C$. The nucleon exchange operator $V_X$ is velocity dependent; its expectation value is calculated to the lowest order of overlap integrals with a wave-function in which each of the interacting $\alpha$-particles is confined to the neighbourhood of a fixed point. It is shown that to this approximation $V_X$ is repulsive for central forces between nucleons, and it is assumed that the complete $V_X$ is responsible for the repulsion required by the $\alpha$-particle model. It is also shown that the tail of $V_X$ is additive or not according to whether the force between nucleons does not or does have a direct component. The magnitude of the non-additive exchange energy which comes from the direct tail of the Serber potential is shown to be so small as to be not inconsistent with an $\alpha$-$\alpha$ interaction which is additive for most purposes. The direct interaction $V_D$ and the polarization interaction $V_{POL}$ are both additive attractive forces reaching out beyond the exchange repulsion. If the force between nucleons does not have a direct tail, then $V_{POL}$ is the only attraction, but is too weak if the forces between nucleons are central. If, however, there is an attractive direct tail, then there is a direct attraction supplemented by $V_{POL}$, and it turns out that the strength of the direct tail in the Serber potential gives the right order of magnitude for the $\alpha$-$\alpha$ attraction. The appeal to a direct component in the force between nucleons leads to the well-known difficulty with saturation, but arguments are given to show that this difficulty is not crippling. It is shown that where the direct attraction predominates, the $\alpha-\alpha$ interaction energy can be represented by a static potential; at shorter separations of the $\alpha$-particles, $V_X$ predominates and the $\alpha$-$\alpha$ interaction can be represented by a potential only if one assumes that because of the strongly repulsive nature of $V_X$ one may replace the latter by an effective repulsive potential. The complete interaction potential between $\alpha$-particles which one obtains in this way agrees in order of magnitude but disagrees in shape with the parabolic potentials which have been used in published treatments of the energy spectra of some $\alpha$-nuclei. It is concluded that the attraction between $\alpha$-particles required by the $\alpha$-particle model can be accounted for if the force between nucleons has a direct component like that in the Serber potential. The mechanism of the attraction entails no more than a small probability of the $\alpha$-particles' being dissolved in nuclei with $A \leq 40$. A.

539.152.1

7287. COMPOUND NUCLEAR THEORY AND THE OPTICAL MODEL. J.Bowcock.
Proc. Phys. Soc. A, Vol. 70, Pt 7, 515-28 (July, 1957).

A formalism is developed to relate the total cross-section for

low-energy nucleon—nucleus scattering to the cross-section due to a potential well. By introducing the intermediate model of Lane, Thomas and Wigner for the compound nucleus states, a simple relation between these two cross-sections is obtained. The method of extracting a potential well to replace the hard sphere scattering and the scattering from "far distant" levels is given and then extended to find the well which describes the average total cross-section. A.

539.152.1 : 539.172

REDUCED STRIPPING-WIDTHS AND THE SHELL MODEL. See Abstr. 6531

539.152.1

7288. A POSSIBLE CORRECTION OF THE SEMI-EMPIRICAL MASS FORMULA. G.Szamosi and M.A.Ziegler.
Acta. phys. Hungar., Vol. 6, No. 2, 345-6 (1956).

Recent studies of the electron scattering and of mesonic atoms indicate a Coulomb radius constant of $1.2 \times 10^{-13}$ cm, involving a change in the numerical values of the constants in the formula. An expression is derived, using Fermi statistics, which fits the experimental values of the binding energy of nuclei and the line of beta-stability over the entire range of atomic number. The value of surface tension considerably exceeds its former value. J.J.Phipps

539.152.1

7289. SHELL EFFECTS IN NUCLEAR COULOMB ENERGY DIFFERENCES. O.Kofoed-Hansen.
Nuclear Physics, Vol. 2, No. 4, 441-9 (Dec., 1956).

The classical formula for nuclear Coulomb energies is abandoned and the Coulomb energies are instead calculated, using simple nuclear models. In agreement with empirical findings, the calculated curves show definite effects of nuclear shell structure. The evaluation of the nuclear radius (defined as $R = [5/3\langle r^2\rangle Av]^{1/2}$) from the data shows that for medium heavy nuclei ($20 < A < 40$) $R = r_0A^{1/3} = 1.24A^{1/3}$, whereas for the very light nuclei $r_0$ becomes somewhat larger. A.

539.152.1

7290. REMARKS ON THE CHARGE DISTRIBUTION IN NUCLEI. L.Rosenfeld.
Nuclear Physics, Vol. 2, No. 4, 450-3 (Dec., 1956).

Careful analysis by Kofoed-Hansen (preceding abstract) has removed the discrepancy in the value of $r_0$ in $R = r_0A^{1/3}$ obtained from mirror nuclei and fast electron scattering data. Until $A = 70$-$80$, $r_0$ decreases and therefore nuclear density increases. The nuclear density then remains constant. This suggests that, as A increases, volume interactions tend to increase the density unlike Coulomb interactions and interactions depending on neutron excess, which give a decrease in density. J.W.Sturgess

539.152.1

7291. STUDY OF COULOMB EXCITATION OF THE SECOND EXCITED STATE OF $Pt^{194}$. R.Barloutaud, T.Grjebine, P.Lehmann, A.Lévêque, J.Quidort and G.M.Temmer.
C.R. Acad. Sci. (Paris), Vol. 244, No. 2, 187-90 (Jan. 7, 1957). In French.

The absence of Coulomb excitation of this excited state shows that the ratio

$$\frac{E_2 \text{ transition probability from 2nd to 1st excited states}}{E_2 \text{ transition probability from 1st excited to ground states}}$$

is at most one eighth of the value predicted for a vibrational level. A.O.Stanesby

539.152.1 : 539.166.2

COULOMB EXCITATION OF Pt AND W. See Abstr. 6521

539.152.1

7292. REPULSION OF NUCLEAR LEVELS. I.I.Gurevich and M.I.Pevsner.
Nuclear Physics, Vol. 2, No. 5, 575-81 (Jan., 1957).

The size distribution of level spacings in the region of compound nucleus excitation energies of the order of the neutron binding energy is considered. By analysing available data derived by neutron spectroscopy, it is shown that the actual size distribution of level spacings qualitatively differs from random distribution. The relative number of near-lying levels is considerably smaller than for a random distribution. The conclusion is drawn that nuclear levels "repel" each other with a distribution approaching equidistance. This conclusion is based on experimental data relating mainly to odd-mass target nuclei. Assuming naturally that only equal spin levels interact, the observed "repulsion" may prove to be less pronounced owing to overlapping of the two sets of levels. A.

539.152.1 : 539.172.13

7293. ENERGY LEVELS IN $Na^{23}$ AND $Ne^{20}$. W.W.Buechner and A.Sperduto.
Phys. Rev., Vol. 106, No. 5, 1008-11 (June 1, 1957).

The energy levels in $Na^{23}$ and $Ne^{20}$ have been investigated by means of the reactions $Na^{23}(p,p')Na^{23}$ and $Na^{23}(p,\alpha)Ne^{20}$. Protons with energies of 7.04, 7.17, and 7.45 MeV were accelerated with an electrostatic generator, and the reaction products were analysed with the broad-range spectrograph at various angles between 45 and 130 degrees. Proton groups were observed corresponding to levels in $Na^{23}$ at 0.440, 2.078, 2.393, 2.641, 2.705, 2.983, 3.678, 3.850, 3.915, 4.431, and 4.778 MeV. The ground-state Q value for the $Na^{23}(p,\alpha)Ne^{20}$ reaction was determined at 2.370 ± 0.008 MeV. Four other alpha-particle groups were observed, corresponding to levels in $Ne^{20}$ at 1.635, 4.248, 4.969, and 5.631 MeV. A.

539.152.1 : 539.166.2

7294. NEUTRON THRESHOLDS IN THE $Co^{59}(p,n)Ni^{59}$ REACTION. J.W.Butler, K.L.Dunning and R.O.Bondelid.
Phys. Rev., Vol. 106, 1224-7 (June 15, 1957).

The $Co^{59}(p,n)Ni^{59}$ reaction has been used to find energy levels in the residual $Ni^{59}$ nucleus by a neutron-threshold technique. Thresholds were found at bombarding energies corresponding to excited states of 0.341, 0.439, 1.22, 1.343, 1.79, 1.964, 2.15, 2.545, 2.72, 3.054, and 3.19 MeV. On the basis of these levels in $Ni^{59}$, some of the thermal-neutron-capture gamma-rays from natural nickel reported by Kinsey and Bartholomew (Abstr. 2670/1953) have been given new isotopic assignments. A.

539.152.1

7295. FINE STRUCTURE OF THE GROUND STATES OF $N^{15}$ AND $O^{17}$. C.A.Pearse.
Phys. Rev., Vol. 106, No. 3, 545-53 (May 1, 1957).

An attempt has been made to fit the experimental values of the ground-state splittings for $N^{15}$ and $O^{17}$ by using the same nucleon—nucleon spin—orbit force for both cases. It is found that the spin—orbit force constants for the $N^{15}$ case must be made about twice as large as those for the $O^{17}$ case. The magnitudes of the spin—orbit force parameters required to account satisfactorily for the $N^{15}$ and $O^{17}$ ground-state splittings have been found to be from 5 to 10 times larger than those necessary to obtain agreement between the calculated and the experimental values of the ground-state splitting in $Li^7$. The exchange-integral contributions to the splittings have been found to be from $\frac{1}{4}$ to $\frac{1}{2}$ of the direct integral contributions; therefore, the concept of a one-body spin—orbit force is not accurately applicable in the cases of the $N^{15}$ and $O^{17}$ ground-state splittings. Gaussian error potentials and wave-functions have been used. The wave-function range parameters have been adjusted by means of experimental Coulomb energies and examined by means of binding energies. Effects of excited configurations have not been included and no claim of an exhaustive consideration of all possible adjustments of wave-function and potential parameters is made. A.

539.152.1

7296. RADIATIVE TRANSITION WIDTHS IN THE lp SHELL. D.Kurath.
Phys. Rev., Vol. 106, No. 5, 975-82 (June 1, 1957).

The nuclear wave-functions, obtained from a shell model with variable strength of spin—orbit coupling, are used to compute M1 and E2 transition widths. Comparison with experiment is made for $Be^8$, $B^{10}$, $B^{11}$, and $C^{12}$. The agreement is not nearly so good as was that obtained for energy level schemes. The pure M1 transitions are in good agreement with experiment. The values computed for E2 transition strengths are found to be generally low, though about the right order of magnitude. This suggests the need for adding some collective behaviour to the model. A.

539.152.1 : 535.43 : 537.531

7297. PHOTON SELF-ABSORPTION AND SCATTERING BY THE 15.1 MeV LEVEL IN $C^{12}$. E.Hayward and E.G.Fuller.
Phys. Rev., Vol. 106, No. 5, 991-5 (June 1, 1957).

Bremsstrahlung X-rays have been used to excite the 15.1 MeV level in $C^{12}$. The integral scattering cross-section of 19.0 ± 0.27 MeV millibarns has been determined by measuring the absolute number by 15.1 MeV X-rays scattered. The peak absorption cross-section 22.2 ± 2.2 barns has been obtained from a self-absorption experiment. These results combine to give 54.5 ± 9.3 eV for the ground-state radiation width and 79 ± 16 eV for the total width of the level. A.

539.152.1 : 539.166.2 : 539.172.11

SPIN OF THE SECOND EXCITED STATE OF $C^{12}$. See Abstr. 6539

539.152.1 : 539.172.4

ENERGY LEVELS OF $O^{18}$. See Abstr. 6580

539.152.2

7298. TRANSITIONS BY INDIRECT RADIATION.
J.Hue and J. Seiden.
C.R. Acad. Sci. (Paris), Vol. 224, No. 16, 2157-60 (April 15, 1957). In French.

Details the theory of inducing transitions in the orientation of nuclei of type A by irradiation with radiation of the nuclear magnetic resonance frequency of a neighbouring nucleus of a different type B. D.H.Whiffen

539.152.2

7299. MAGNETIC MOMENTS OF NUCLEI AND THE NUCLEAR MANY-BODY PROBLEM. J.S.Bell, R.J.Eden and T.H.R.Skyrme.
Nuclear Physics, Vol. 2, No. 5, 586-92 (Jan., 1957).

In recent work on the nuclear many-body problem momentum-dependent potentials have been used to describe the motion of individual particles, and this has led to some uncertainty in regard to electromagnetic interactions, especially magnetic moments. In this paper the causes of momentum dependence of the potentials are discussed, and it is shown that some of these do not lead to any change in magnetic moments, whilst others may affect them but not simply in the way indicated by the "reduced mass" approximation to the potentials. The magnetic moment operator is in any case ambiguous in that it involves the unknown functions familiar from studies of exchange currents. A.

539.152.2

7300. RATIO OF THE MAGNETIC MOMENTS OF $In^{115}$ AND $In^{113}$. M.Rice and R.V.Pound.
Phys. Rev., Vol. 106, No. 5, 953 (June 1, 1957).

A new measurement of the ratio of the nuclear magnetic resonance frequencies of $In^{115}$ and $In^{113}$ in a solution of $In(ClO_4)_3$ yields $\mu(In^{115})/\mu(In^{113}) = 1.002\,143\,7 \pm 0.000\,001\,2$. This can be combined with the h.f.s. measurements of Eck et al. (see the two abstracts which follow) to determine the h.f.s. anomalies. A.

539.152.2 : 539.153.4

7301. H.F.S. OF THE $5\,^2P_{1/2}$ STATE OF $In^{115}$ AND $In^{113}$. H.F.S. ANOMALIES IN THE STABLE ISOTOPES OF INDIUM.
T.G.Eck, A.Lurio and P.Kusch.
Phys. Rev., Vol. 106, No. 5, 954-7 (June 1, 1957).

The h.f.s. splittings of the $5\,^2P_{1/2}$ states of $In^{115}$ and $In^{113}$ have been measured by the atomic-beam magnetic-resonance method. It is found:

$$\Delta\nu(In^{115}) = [11\,409.7506 \pm (20)] \times 10^6\ sec^{-1},$$
$$\Delta\nu(In^{113}) = [11\,385.4300 \pm (20)] \times 10^6\ sec^{-1}.$$

A comparison of the ratio of the dipole coupling constants of the two isotopes in the $P_{1/2}$ state and in the $P_{3/2}$ state with the ratio of the nuclear $g_I$ factors yields the following h.f.s. anomalies:

$$\Delta_{1/2} = (7.5 \pm 1.3) \times 10^{-6},\quad \Delta_{3/2} = -(23.8 \pm 1.3) \times 10^{-6}.$$

The fractional change in the nuclear radius between $In^{113}$ and $In^{115}$, $\delta R/R$, is found to be $3.66 \times 10^{-3}$ as compared to $5.85 \times 10^{-3}$ calculated on the assumption of an incompressible nucleus. A.

539.152.2 : 539.153.4

7302. H.F.S. OF THE $5\,^2P_{3/2}$ STATE OF $In^{115}$ AND $In^{113}$. OCTUPOLE INTERACTIONS IN THE STABLE ISOTOPES OF INDIUM. T.G.Eck and P.Kusch.
Phys. Rev., Vol. 106, No. 5, 958-64 (June 1, 1957).

The zero-field h.f.s. intervals in the $5\,^2P_{3/2}$ state of $In^{113}$ have been measured by the use of conventional atomic-beam techniques. The magnetic octupole interaction constants for these atomic systems are determined from the measured intervals and corrected for perturbations of the electronic states. They are

$$c'(In^{115}) = [0.001\,702 \pm (35)] \times 10^6\ sec^{-1},$$
$$c'(In^{113}) = [0.001\,728 \pm (45)] \times 10^6\ sec^{-1}.$$

The estimated values of the nuclear magnetic octupole moments of $In^{115}$ and $In^{113}$ are compared to the predictions of the single-particle and collective models of the nucleus. A.

539.152.2

7303. DETERMINATION OF THE SIGN OF THE $He^3$ NUCLEAR MAGNETIC MOMENT. M.P.Klein and B.E.Holder.
Phys. Rev., Vol. 106, No. 6, 837 (May 15, 1957).

A direct comparison between the signs of the proton and the $He^3$ nuclear magnetic moments has been made by a nuclear resonance method. The proton and $He^3$ are shown to have nuclear magnetic moments of opposite sign and so the $He^3$ moment is shown to be negative. L.L.Green

539.152.2

7304. NUCLEAR MOMENTS OF INERTIA. T.H.R.Skyrme.
Proc. Phys. Soc. A, Vol. 70, Pt 6, 433-44 (June, 1957).

A formula proposed by the author for the calculation of the moment of inertia of a nuclear system is discussed. A simple calculation using the model of a deformed oscillator well for the mean nuclear potential gives the result $M\Sigma z^2$ for a prolate distribution, approximately half the rigid moment; it is suggested that this result incorporates most of the effects of the residual interactions between nucleons. The problem of other potential shapes and the velocity-dependence of the potential is discussed qualitatively. A.

539.152.2

7305. HYPERFINE STRUCTURE IN MANGANESE $^{55}_{25}Mn$.
G.K.Woodgate and J.S.Martin.
Proc. Phys. Soc. A, Vol. 70, Pt 7, 485-8 (July, 1957).

The hyperfine structure of the ground state $3d^54s^2\,{}^6S_{5/2}$ of $Mn^{55}$ has been measured in a resonance experiment with an atomic beam. The value 5/2 for the nuclear spin has been confirmed by measurements in weak fields. The magnetic dipole interval factor is $A(^6S_{5/2}) = 72.422 \pm 0.002$ Mc/s. There is no departure from the interval rule outside experimental error. A.

539.152.2

7306. THE RATIOS OF THE MAGNETIC SPIN AND QUADRUPOLE MOMENTS OF THE NUCLEI $U^{233}$ AND $U^{235}$.
N.I.Kaliteevskiĭ and M.P.Chaĭka.
Optika i Spektrosk., Vol. 1, No. 6, 809-11 (1956). In Russian.

Re-investigation of several lines of $U^{235}$ gave the nuclear spin a value of 7/2. Certain of the calculations described in previous work (Abstr. 212/1956) were repeated with the conclusion that the ratios $U^{233}/U^{235}$ of the magnetic and quadrupole moments are $-1.6 \pm 0.1$ and $+0.8 \pm 0.3$, respectively. L.Bovey

539.153.4 : 530.145

7307. ON THE KINEMATIC PROPERTIES OF A SYSTEM OF TWO DIRAC PARTICLES.
H.Joos, J.Leal Ferreira and A.H.Zimerman.
An. Acad. Brasil. Ciênc., Vol. 28, No. 3, 253-74 (1956).

A description of two Dirac particles by sixteen component spinor wave-functions is employed to show that every wave equation for such a system, which is invariant under reflection and rotation, can be decomposed into two independent groups of eight radial equations. Considering these equations in a representation where the relative radial velocity $c(\alpha^{(2)} - \alpha^{(1)})(\vec{r}/r)$ is diagonal, they decompose into four differential and four algebraic equations. The latter can be used to eliminate the superfluous components of the wave-functions; this elimination is applied to Hamiltonians with Coulomb and Breit interactions in the hydrogen atom. From the resulting exact equations, approximations are derived, which take into account the movement of the nucleus. A.

539.153.4

7308. HYPERFINE STRUCTURE OF POSITRONIUM AND ITS GROUND STATE. V.W.Hughes, S.Marder and C.S.Wu.
Phys. Rev., Vol. 106, No. 5, 934-47 (June 1, 1957).

The energy difference between orthopositronium and parapositronium in the ground n = 1 state, which is called the hyperfine structure separation $\Delta\nu$, has been determined. The frequency difference between the M = ±1 and the M = 0 Zeeman levels of orthopositronium was measured in a static magnetic field of 8000 gauss at which it is about 2460 Mc/s. A resonance curve was taken with fixed frequency by varying the magnetic field, and an observed fractional line width, $\Delta H_0/H_0$, of about $4.5 \times 10^{-3}$ was obtained. The principal part of the line width ($3.6 \times 10^{-3}$) is due to the annihilation lifetime of positronium; microwave power broadening and magnetic field inhomogeneity account for the remainder. No Doppler broadening is present despite the high velocity of the positronium atoms, because the mean free path of a positronium atom in the gas is small compared to the wavelength of the microwave radiation. The value of $\Delta\nu$ was computed from the observed values of the frequency and magnetic field at resonance by use of the Breit–Rabi formula to give the result: $\Delta\nu = (2.0333 \pm 0.0004) \times 10^5$ Mc/s. The error quoted is 5 times the statistical error and is believed to represent an upper limit to possible systematic errors. The value agrees with the values of Deutsch et al. of $(2.0338 \pm 0.0004) \times 10^5$ Mc/s and $(2.0335 \pm 0.0005) \times 10^5$ Mc/s, obtained with fields of 9500 and

9000 gauss, respectively, and hence confirms the use of the Breit–Rabi formula. The experimental values agree with the theoretical value for $\Delta\nu$ of 2.0337 x $10^5$ Mc/s computed to order $\alpha^3$ rydberg by Karplus and Klein. A.

539.153.4

7309. RELATIVISTIC CORRECTIONS TO THE DIPOLE SUM RULE. J.S.Levinger, M.L.Rustgi and K.Okamoto.
Phys. Rev., Vol. 106, No. 6, 1191-4 (June 15, 1957).

The summed oscillator strength is calculated to order $(v/c)^2$ for a Dirac electron in a central force field. The result $(1+T_{00})^{-1}$ is interpreted in terms of the electron's increase of mass due to its kinetic energy. ($T_{00}$ is the expectation value of the kinetic energy, in units of $mc^2$). This analytical result is in fair agreement with the present authors' earlier numerical result, and those of Brown et al. (Abstr. 2674/1953, 2155/1955, 4621/1956) for a K-electron of lead. Also the bremsstrahlung-weighted cross-section is calculated for a Dirac electron in a Coulomb field, and compare with the numerical result for lead. A.

539.153.4 : 537.533.9

7310. EXCITATION OF METASTABLE LEVELS IN HELIUM NEAR THRESHOLD. G.J.Schulz and R.E.Fox.
Phys. Rev., Vol. 106, No. 6, 1179-81 (June 15, 1957).

The excitation of the metastable levels in helium ($2\,^3S$ and $2\,^1S$) was studied as a function of electron energy near threshold. The excitation due to essentially monoenergetic electrons was obtained by using the retarding potential method. The metastables were detected by their emission of electrons from a gold-plated cylinder. It was found that the excitation function for the $2\,^3S$ level is linear from the onset of excitation to approximately 0.4 eV above onset except for a small amount of tailing near threshold. The excitation function peaks at 0.6 eV above the excitation threshold. The value of the cross-section of the $2\,^3S$ level is in reasonable agreement with the value given by Maier-Leibnitz. A.

539.153.4 : 537.533.9

7311. HELIUM EXCITATION CROSS SECTIONS NEAR THRESHOLD. E.Baranger and E.Gerjuoy.
Phys. Rev., Vol. 106, No. 6, 1182-5 (June 15, 1957).

The cross-section for excitation by incident electrons of the $^3S_1(1s,2s)$ metastable level of He has been fitted by using a Breit–Wigner one-level formula. The fit is very good The significance of this result and its bearing on the energy dependence of the cross-section near threshold are discussed. A.

539.153.4 : 537.533.9

7312. THE EXCITATION OF THE DISCRETE LEVELS OF ATOMIC HYDROGEN BY FAST ELECTRONS. R.McCarroll.
Proc. Phys. Soc. A, Vol. 70, Pt 6, 460-5 (June, 1957).

The cross-sections for the excitation of normal hydrogen atoms to the fifth and higher levels have been obtained by interpolation from the Born cross-sections for the excitation to the second, third and fourth levels, and for ejection into the continuum. The cross-section describing the excitation of all levels and the energy loss sustained by the incident electron are hence derived. A.

539.153.4 : 539.152.2

5 $^2P_{1/2}$ AND 5 $^2P_{3/2}$ STATES OF $In^{115}$ AND $In^{113}$. See Abstr. 7301, 7302

539.155.1 : 539.152.1

7313. NEW EMPIRICAL EQUATION FOR ATOMIC MASSES. H.B.Levy.
Phys. Rev., Vol. 106, No. 6, 1265-70 (June 15, 1957).

A new empirical equation for atomic masses has been developed. This equation has been successfully applied to atomic masses of nuclides heavier than nickel. The form used is that of an expression for the mass defect, $\Delta M = M - A$, as a function of Z and A: $\Delta M(A,Z) = \alpha_0 + \alpha_1 A + \alpha_2 Z + \alpha_3 AZ + \alpha_4 Z^2 + \alpha_5 A^2 + \delta$. Because of the effects of nuclear shell structure a different set of coefficients is necessary for the different nuclear shell regions. Atomic masses calculated from this equation agree with experimental mass values to within ±0.5 millimass units in 75% of the 340 nuclides studied and agree to within ±1.5 millimass units in 95% of the nuclides. Beta-decay energies were calculated with the new equation and checked against a total of 179 experimental values. Agreement of calculated values with experiment was better than ±0.5 MeV in 95% of the cases and within ±0.25 MeV in 84%. A.

539.155.2

7314. SOME UPPER LIMITS OF ISOTOPIC ABUNDANCE. II. Ne, Cl, and Ga. L.Kerwin and D.E.McElcheran.
Canad. J. Phys., Vol. 34, No. 12B, 1497 (Dec., 1956).

For Pt I see Abstr. 2564/1957. The present status of the isotopic abundances of the above elements are given, including values for the upper limits for rare isotopes obtained by the authors. H.C.Cole

539.155.2 : 539.172.3

7315. ENRICHMENT OF THE RADIOACTIVE ISOTOPES OF IODINE, GERMANIUM, ARSENIC AND ANTIMONY, OBTAINED THROUGH THE ($\gamma$,n) REACTION. A.N.Murin, V.D.Nefedov, V.L.Baranovskii and D.K.Popov.
Dokl. Akad. Nauk SSSR, Vol. 111, No. 4, 806-7 (1956). In Russian.

Variants of the Szilard–Chalmers separation process, applied to targets bombarded by $\gamma$-rays of 265 MeV maximum energy, yielded enrichment factors of $10^3$-$10^4$. The results are tabulated. W.O.Lock

539.155.2

7316. INFLUENCE OF THE CATHODE METAL ON THE SEPARATION OF HYDROGEN ISOTOPES. PRELIMINARY COMMUNICATION. J.Brun, T.Varberg, W.Gundersen and R.Solli.
K. Norske Vidensk. Selsk. Forhandl., Vol. 29, Paper 2, 5-9 (1956).

539.156 : 535.349

7317. MODULATION OF A LIGHT BEAM BY PRECESSING ABSORBING ATOMS. H.G.Dehmelt.
Phys. Rev., Vol. 105, No. 6, 1924-5 (March 15, 1957).

Theoretical considerations on experiments in which such an effect might be observed, related to those described in Abstr. 1520, 6470/1957. J.Hawgood

539.156

7318. THE CONSERVATION OF PHASE AT THE TIME OF COLLISION BETWEEN AN ORIENTED SODIUM ATOM AND AN ATOM OF HELIUM. C.Cohen-Tannoudji, J.Brossel and A.Kastler.
C.R. Acad. Sci. (Paris), Vol. 244, No. 8, 1027-9 (Feb. 18, 1957). In French.

In studying the magnetic resonance spectrum of optically oriented sodium vapour, it was observed that the presence of a foreign gas at a pressure of a few tenths of a millimetre of mercury, augmented not only the intensity but also greatly increased the sharpness of the line. The effect is explained in terms of phase conservation in collisions between sodium and foreign gas atoms (helium in this case). R.W.Nicholls

539.156

7319. THE INFLUENCE OF RETARDATION ON THE LONDON–VAN DER WAALS FORCE. M.R.Aub, E.A.Power and S.Zienau.
Phil. Mag. (Eighth Ser.), Vol. 2, 571-2 (April, 1957).

A recalculation shows that a recent perturbation calculation by Leech (Abstr. 2335/1956) of the retarded interaction between two atoms which predicts an $R^{-3}$ dependence is in error, and that in agreement with Casimir and Polder (Abstr. 1286/1948) and $R^{-6}$-$R^{-7}$ dependence is to be expected. R.W.Nicholls

## RADIOACTIVITY. $\alpha$-, $\beta$- AND $\gamma$-RAYS 539.16

539.16 : 551.594.14

RADIOACTIVE FALLOUT. See Abstr. 6778

539.16.08

7320. THE USE OF PARALDEHYDE TO INCORPORATE LARGE AMOUNTS OF TRACER CARBON IN A LIQUID SCINTILLATOR. C.Léger and L.Pichat.
C.R. Acad. Sci. (Paris), Vol. 244, No. 2, 190-2 (Jan. 7, 1957). In French.

Considerable quantities of "traceable" carbon can be introduced in the form of paraldehyde into a liquid scintillator; using as standard xylene containing 300 $g.l^{-1}$ of naphthalene and 3 $g.l^{-1}$ of diphenyl-2.5-oxazole, paraldehyde could be added up to 90% by volume (400 $g.l^{-1}$) with a reduction in scintillation amplitude to one-half. A.O.Stanesby

539.16.08 : 536.422.1

SEARCH FOR RADIOACTIVITY IN WIRE EXPLOSIONS. See Abstr. 7058

539.162 : 539.154.2

7321. THE LAWS OF DISTRIBUTION OF THE ARTIFICIALLY RADIOACTIVE NUCLEI ABOUT THE STABLE NUCLEI. P.Dassault.
C.R. Acad. Sci. (Paris), Vol. 244, No. 9, 1108-11 (Feb. 25, 1957). In French.

It is pointed out that for every value of Z there is at least one pair of stable nuclides (Z, A), (Z-1, A-1); to each such pair there corresponds a radioactive pair (Z-1, A), (Z, A-1) the decay of which

is governed by the stability of the neighbouring isobars. These rules lead to the prediction that $Bi^{208}$ will be radioactive.

M.A.Grace

539.162

7322. SCATTERING IN THE SOURCE AND ANGULAR CORRELATIONS. J.Berthier.
C.R. Acad. Sci. (Paris), Vol. 244, No. 10, 1355-8 (March 4, 1957). In French.

Approximate calculations for spherical sources are outlined, and numerical results are given, graphically, for cobalt sources of radius $r \leq 2$ mm. The results indicate that scattering is important for $r > 0.3$ mm. Experimental results are quoted in confirmation of the calculations. J.J.Wilkins

539.163

7323. A NEW NEUTRON-DEFICIENT ISOTOPE OF SELENIUM. J.Beydon, H.Faraggi, I.Gratot and M.Le Pape.
C.R. Acad. Sci. (Paris), Vol. 244, No. 5, 586-9 (Jan. 28, 1957). In French.

A new $\beta$-emitting isotope of Se with a half-life of $5 \pm 2$ min and emitting a $\gamma$-ray of about 160 keV was obtained by bombarding Cu by N ions; the mass is 71 or perhaps 69. A.O.Stanesby

539.163.1

7324. CONTRIBUTION TO THE STANDARDIZATION OF RADIOACTIVE ELEMENTS. MEASUREMENT OF RADIOACTIVE LIFETIMES. H.Thiry.
Bull. Soc. Roy. Sci. Liège, Vol. 26, No. 1, 29-39 (Jan., 1957). In French.

The lifetimes of certain radioactive elements have been measured with a Geiger counter by plotting decay curves using uranium oxide as a standard. Results are $Hg^{203}$: $47.1 \pm 0.2$ days; $Tb^{160}$: $73.0 \pm 0.5$ days; $Ag^{110}$: $253 \pm 4$ days; $Ca^{45}$: $153 \pm 2$ days; $W^{185}$: $70.0 \pm 0.8$ days. J.W.Sturgess

539.163.1

7325. THE HALF-LIFE OF THE 396 keV LEVEL OF $Lu^{175}$. H.Vartapetian.
C.R. Acad. Sci. (Paris), Vol. 244, No. 1, 65-8 (Jan. 2, 1957). In French.

Using the delayed-coincidence technique, the half-life was measured and found to be $(3.4 \pm 0.3) \times 10^{-9}$ sec. A.O.Stanesby

539.163.1

7326. NEW HALF-LIFE IN THE FAMILY OF ANTIMONY ISOTOPES. H.Bosch and H.Munczek.
Phys. Rev., Vol. 106, No. 5, 983-5 (June 1, 1957).

By using scintillation techniques in analysing the $\gamma$-radiation following the $\beta$-decay of a fission-product antimony sample, evidence of a new half-life of $149 \pm 4$ hours was found in the family of antimony isotopes. A.

539.163.2

7327. RADIOACTIVE ISOTOPES OF THE RARE EARTHS, FORMED IN A SPALLATION REACTION. G.M.Gorodinskiĭ, A.N.Murin, V.N.Pokrovskiĭ, B.K.Preobrazhenskiĭ and N.E.Titov.
Dokl. Akad. Nauk. SSSR, Vol. 112, No. 3, 405-6 (1957). In Russian.

A summary of the characteristics of the radioactive isotopes of the rare earths found when tantalum is bombarded with 680 MeV protons. A new isotope $Gd^{147}$, is claimed; new data on the $\gamma$-spectra of some of the isotopes is reported. W.O.Lock

539.163.2 : 539.152.1

7328. ISOMERIC TRANSITIONS IN THE RARE-EARTH ELEMENTS. C.L.Hammer and M.G.Stewart.
Phys. Rev., Vol. 106, No. 5, 1001-7 (June 1, 1957).

A search was made for isomeric transitions in the rare-earth elements with half-lives greater than 5 microseconds and less than ~30 minutes which arise in the decay of photoexcited nuclei. Four isomeric transitions were found and identified as follows: $Tb^{158}$, $50 \text{ keV} < E < 200$ keV, $11.0 \pm 0.1$ sec, M3 or E3; $Ho^{163}$, 305 keV, $0.8 \pm 0.1$ sec, E3; $Er^{165, 167, \text{ or } 169}$, 213 keV, $2.5 \pm 0.1$ sec, E3; $Lu^{174}$, 133 keV, $75 \pm 2$ microseconds, E2. These results are compared with the predictions of the nuclear models which have been proposed by Nilsson and Gottfried. A.

539.163.2

7329. DECAY PROPERTIES OF $Pu^{235}$, $Pu^{237}$, AND A NEW ISOTOPE $Pu^{233}$. T.D.Thomas, R.Vandenbosch, R.A.Glass and G.T.Seaborg.
Phys. Rev., Vol. 106, No. 6, 1228-32 (June 15, 1957).

Electron-capture and alpha-decay properties of $Pu^{237}$, $Pu^{235}$, and the new isotope $Pu^{233}$ have been measured. The over-all half-lives are $44 \pm 2$ days for $Pu^{237}$, $26 \pm 2$ minutes for $Pu^{235}$, and $20 \pm 2$ minutes for $Pu^{233}$. Two alpha-groups, one of $5.65 \pm 0.02$ MeV and one of $5.36 \pm 0.02$ MeV, were detected in the decay of $Pu^{237}$, one group of $5.85 \pm 0.02$ MeV in the decay of $Pu^{235}$, and one of $6.30 \pm 0.02$ MeV in the decay of $Pu^{233}$. The partial alpha half-lives corresponding to these alpha groups are, for $Pu^{237}$, $(1.7 \pm 0.4) \times 10^4$ years and $(4.6 \pm 0.6) \times 10^3$ years, respectively; for $Pu^{235}$, $(1.7 \pm 0.4)$ years; and for $Pu^{233}$, $11 \pm 4$ days. On the basis of the experimental data it has been possible to calculate hindrance factors for the alpha-decay and log ft values for the electron-capture decay of the three isotopes and to correlate their properties with the alpha and electron-capture systematics. A.

539.163.2 : 539.152.1

7330. SOME NEW ISOMERIC TRANSITIONS IN RARE EARTH NUCLEI. J.W.Mihelich and B.Harmatz.
Phys. Rev., Vol. 106, No. 6, 1232-5 (June 15, 1957).

The following isomeric transitions have been observed in neutron-deficient rare earth isotopes: $Tb^{156m}$ (5.5 hr) 88.2 keV (E3); $Ho^{160m}$ (5.0 hr) 60.1 keV (E3); $Er^{167m}$ (2.5 sec) 208 keV (E3); $Er^{168m}$ ($10^{-7}$ sec); and $Yb^{171m}$ ($T_{1/2}$?) 75.8 keV (E3). All the E3 transitions may proceed between levels predicted by Mottelson and Nilsson. A.

539.163.2 : 539.152.1

7331. ON THE 208/113 keV $\gamma$–$\gamma$ CASCADE IN HAFNIUM$^{177}$. K.G.Steffen.
Z. Phys., Vol. 147, No. 2, 132-40 (1957). In German.

The angular correlation of the 208 and 113 keV gamma-rays was measured, leading to an assignment $9/2^+$ for the 321 keV level, assuming $7/2^-$, $9/2^-$, and $11/2^-$ for the lowest three states. The 113 keV radiation is found to be a mixture of 3.4% M1 and 96.6% E2. J.W.G.Wignall

539.164

7332. ON THE $\alpha$-PARTICLES EMITTED BY PHOTONUCLEAR REACTIONS IN COPPER, NICKEL AND ALUMINIUM. F.Bobard, G.Boulègue and P.Chanson.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1761-3 (March 25, 1957). In French.

Thin targets of Cu, Ni and Al were irradiated by a 30.5 MeV betatron beam, and the $\alpha$-particles emitted at various angles were detected in nuclear emulsions. No variations with angle were found. Energy distributions of the $\alpha$-particles are plotted, those for Cu and Ni being as expected from statistical theory (strongly peaked at about 8 MeV). For Al, the intensity decreases with energy above 5 MeV; reliable measurements for $\alpha$-particles below 5 MeV could not be obtained. Absolute cross-section values are given and discussed, the results for Cu being compatible with existing experimental data. J.J.Wilkins

539.164 : 539.166

7333. ON THE RATIO BETWEEN $\gamma$- AND $\alpha$-ACTIVITIES IN $^{210}$Po. A.Ascoli, M.Asdente and E.Germagnoli.
Nuovo Cimento (Ser. 10), Vol. 4, No. 4, 946-7 (Oct., 1956).

So that the weak $\gamma$-ray intensity could be used to calibrate $\alpha$-ray intensity of strong $Po^{210}$ sources the ratio of intensities was determined experimentally and it was found that $I_\gamma / I_\alpha = (1.21 \pm 0.08) \times 10^{-5}$. Scintillation detectors were used both for the $\alpha$ and $\gamma$ activities and brief experimental details are given. L.E.Mussell

539.165

7334. INTERACTION OF BETA PARTICLES WITH MATTER. R.H.Müller.
Analyt. Chem., Vol. 29, No. 6, 969-75 (June, 1957).

Of the several phenomena involved in the interaction of beta-particles with matter, systematic studies on the relative back-scattering of betas by matter have shown that simple regularities obtain for all elements and compounds, and that these can be measured with high precision. The measurements have been applied to solids, liquids, and solutions. Values predicted for pure crystalline solids can be checked to a precision close to that with which the atomic weights are known. A

539.165

7335. INTERACTION OF BETA PARTICLES WITH ORGANIC COMPOUNDS. D.C.Müller.
Analyt. Chem., Vol. 29, No. 6, 975-8 (June, 1957).

The general principles which govern the backscattering of beta-particles from atoms and molecules are applied to some representative organic compounds. The anomaly of hydrogen is resolved and a reliable value is fixed for it. The behaviour of isomers is described and proof is given that the backscattering of compounds is accurately predictable from the intrinsic scattering of the constituent atoms. A

539.165

7336. INVESTIGATION OF INTERNAL CONVERSION LINES IN THE β-SPECTRUM OF A MIXTURE OF $Eu^{152}$ AND $Eu^{154}$ ISOTOPES. V.M.Kelman, V.A.Romanov, R.Ya.Metskhvarishvili and V.A.Kolyunov.
Nuclear Physics, Vol. 2, No. 4, 395-407 (Dec., 1956).

A high resolution prism β-spectrometer was employed to measure the K-shell and L- and M-subshell internal conversion lines of $Sm^{152}$ and $Gd^{154}$. Internal conversion coefficient ratios for transition energies of 122 and 123.2 keV were also determined. Energy differences between the conversion lines were measured with a high degree of precision. A.

539.165.08

7337. ABSOLUTE β-COUNTING OF PREPARATIONS OF SATURATION THICKNESS. J.Heintze and H.Fischbeck.
Z. Phys., Vol. 147, No. 3, 277-87 (1957). In German.

This was carried out using a continuous-flow methane proportional-counter with $2\pi$ geometry; the basic equation is $n = a\sigma\bar{R}$, where n = no. of β-particles emitted by the source per $cm^2$ per sec, σ = specific activity in disintegrations per sec per mg, $\bar{R}$ = range in Al of the β-spectrum in $mg/cm^2$, and a is a factor (~ 0.25) which varies slowly with the β-particle energy and with the atomic no. of the source backing. Representative experimental values are given; an accuracy of about 5% is attainable. A.O.Stanesby

539.165.2 : 539.172.13 : 539.152.1

7338. DETERMINATION OF THE AVAILABLE ENERGY FOR THE $\beta^+$-DISINTEGRATION OF THE LONG-LIVED ISOMER OF TECHNETIUM 95. C.Lévi and L.Papineau.
C.R. Acad. Sci.(Paris), Vol. 244, No. 10, 1358-61 (March 4, 1957). In French.

The threshold $Mo^{95}(p,n)Tc^{95}$ was re-determined as 2.47 ± (± 0.03 MeV, corresponding to an available $\beta^+$-energy for 60-day $Tc^{95}$ of 710 ± 30 keV. The threshold observed at 3.19 ± 0.03 MeV corresponds to an excited state of $Tc^{95}$. A.O.Stanesby

539.165.2

7339. BETA-DECAY INTERACTION WHICH DOES NOT CONSERVE PARITY. R.Nataf.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1917-18 (April 1, 1957). In French.

The coupling constants may be complex when parity is not conserved, and the Fierz interference term is modified accordingly. J.M.Cassels

539.165.8 : 539.166.1

7340. CONTRIBUTION TO THE STUDY OF THE PHENOMENA OF INTERNAL BREMSSTRAHLUNG AND OF SELF-IONIZATION ASSOCIATED WITH β-DISINTEGRATION. H.Langevin-Joliot.
Ann. Phys. (Paris), Vol. 2, No. 1-2, 16-66 (Jan.-Feb., 1957). In French.

By means of a γ-ray spectrometer employing a NaI scintillation detector, a study was made of the spectral distribution of the internal bremsstrahlung in $P^{32}$, $S^{35}$, $Pr^{143}$ and $Pm^{147}$. External bremsstrahlung spectra in C and Al were also obtained. In general the intensity of the internal radiation was over four times larger than given by the theory of Knipp and Uhlenbeck. This disagreement seems largely due to the effect of the Coulomb field. A study with a proportional counter of the K-radiation following self-ionization gave the probability of ionization of the K-shell as $1.3 \times 10^{-4}$ for Pm and $4.25 \times 10^{-4}$ for Pr, in agreement with theoretical predictions. L.Pincherle

539.165.8 : 539.166.1

7341. CONTRIBUTION TO THE STUDY OF THE SECONDARY PHENOMENA ACCOMPANYING THE TRANSITIONS WITH β-EMISSION AND WITH ELECTRON CAPTURE. A.Michalowicz.
Ann. Phys. (Paris), Vol. 2, No. 1-2, 116-62 (Jan.-Feb., 1957). In French.

Concerned particularly with the internal bremsstrahlung. Results on spectral distribution obtained by means of a γ-ray scintillation spectrometer are given for the β-emitters $P^{32}$, $Y^{90}$, and RaE. Some experimental values on the external bremsstrahlung and on internal and external ionization are also given. The radiation accompanying electron capture was studied in $Fe^{55}$ and $Cs^{131}$. Results on $Cs^{131}$ obtained with a coincidence spectrometer indicate the inadequacy of a theory which takes into account only K-capture. L.Pincherle

539.166

7342. ANGULAR DISTRIBUTION OF THE 8.34 MeV γ-RADIATION FROM THE REACTION $N^{14}(p,\gamma)O^{15}$.
S.Gorodetzky, A.Gallmann, M.Croissiaux and R.Armbruster.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1759-61 (March 25, 1957). In French.

The experimental distribution can be represented by $W(\theta) = 1 + (0.051 \pm 0.010)P_2 + (0.0018 \pm 0.022)P_4$ and is compatible only with a value of $J = 3/2$ for the 8.34 MeV state of $O^{15}$. A.O.Stanesby

539.166

7343. MEASUREMENT OF CIRCULARLY POLARIZED GAMMA-RADIATION FOLLOWING POLARIZED NEUTRON CAPTURE. G.Trumpy.
Nuclear Physics, Vol. 2, No. 6, 664-79 (Feb., 1957).

Circular polarization of the γ-rays emitted from nuclei capturing polarized neutrons was studied by means of the dependence of the Compton cross-section upon the relative spin direction of the photon and the electron. Thermal neutrons polarized by transmission through magnetized iron fell on the (n,γ)-target, and the γ-rays were detected by two NaI(Tl)-crystals after passing through analysers of iron magnetized in the direction of transmission. Measurements were carried out with the strongest neutron capture γ-rays from S, Ca, Ti, Cr, Fe, Ni, Zn and W. From the results, some of the spin-values of these nuclei could be derived. The degree of circular polarization was in accordance with theory. A.

539.166

7344. DIRECTIONAL CORRELATION MEASUREMENTS IN $Fe^{57}$. T.Lindqvist and E.Heer.
Nuclear Physics, Vol. 2, No. 6, 680-6 (Feb., 1957).

The directional correlation of the 123 keV and 14 keV gamma lines in $Fe^{57}$ has been investigated. The mother nucleus is the 270 day $Co^{57}$, decaying by K-capture to $Fe^{57}$. The influence of self absorption and scattering in the source as well as the influence of the chemical form of the source was investigated. In the correlation function $W(\theta) = 1 + A_2P_2(\cos\theta) + A_4P_4(\cos\theta)$ the coefficients $A_2$ and $A_4$ were determined as $A_2 = -0.024 \pm 0.003$, $A_4 = 0 \pm 0.01$. Mixing ratios of the gamma-rays are discussed. A.

539.166.08 : 548.57

PREPARATION OF HIGH-SENSITIVITY CADMIUM SULPHIDE CELLS FOR GAMMA-RAY DETECTION. See Abstr. 6696

539.166.2

7345. VARIATION OF $\Gamma_\gamma(E1)/\Gamma_n$ WITH ENERGY. J.Goldemberg.
An. Acad. Brasil. Ciênc., Vol. 28, No. 4, 413-18 (1956). In Spanish.

A method is suggested for comparison with experiment of the measured transition probabilities for gamma-radiation in highly excited states; one compares the theoretical ratio of gamma and neutron emissions with the experimental one. In this manner unknown factors like level densities which are mainly responsible for strong disagreement with theory drop out. The significance of the method for the independent-particle model of nuclei is pointed out. A.

539.166.2

7346. ON THE POSSIBLE ELECTRIC MONOPOLE TRANSITION IN Se 76. G.Bäckström.
Ark. Fys., Vol. 11, Paper 25, 357-9 (1956).

The 0.64-0.55 MeV γ-ray cascade in $Se^{76}$ is known to arise from transitions between spins 2+, 2+ 0+. By comparing the internal conversion coefficients of these two γ-rays and knowing the M1/E2 mixing ratio in the 0.64 MeV transition it is concluded that the EO intensity is less than 0.2%. M.A.Grace

539.166.2 : 539.152.1

7347. GAMMA RADIATION FOLLOWING PROTON CAPTURE IN $^{35}Cl$, $^{37}Cl$ AND $^{39}K$. II. ANGULAR DISTRIBUTIONS AND CORRELATIONS. R.Berenbaum and J.H.Matthews.
Proc. Phys. Soc. A, Vol. 70, Pt 6, 445-51 (June, 1957).

For Pt I, see Abstr. 3611 (1957). Angular distribution measurements and on angular correlation measurement have been made on a number of the γ-rays observed in the reactions $Cl^{35}(p,\gamma)A^{36}$, $Cl^{37}(p,\gamma)A^{38}$ and $K^{39}(p,\gamma)Ca^{40}$ described in an earlier paper (Pt I). From the results of these measurements the following probable assignments can be made to the levels in $A^{36}$, $A^{38}$ and $Ca^{40}$: in $K^{39}$ + p 1120, 1300 and 1566 keV resonances, $1^{\pm}(2^-)$; in $Cl^{37}$ + p 1533 keV resonance, $2^{(-)}$; in $Cl^{35}$ + p 1510 keV resonance, $1^{\pm}(2^-)$; and 850 keV resonance, $3^{(+)}$. For the bound states observed in $A^{36}$: 1.95 MeV, $2^{(+)}$; 4.1 MeV, $3^{(-)}$. A.

539.166.2 : 539.152.1

7348. ON THE INFORMATION ABOUT β-INTERACTION AND NUCLEAR LEVELS DERIVED FROM THE POLARIZATION OF X-RAY QUANTA. A.Z.Dolginov.
Nuclear Physics, Vol. 2, No. 6, 723-35 (Feb., 1957).

It is shown that the sign and magnitude of the ratio of the scalar

and tensor $\beta$-interaction constants can be determined by observing the polarization of X-ray quanta emitted when the vacancy in the atomic shell is filled after allowed K-capture. It is suggested for this purpose that the correlation between circular polarization of the X-ray quanta and the direction of pre-dominant orientation of nuclear spins in an external field be studied. If there is no external field but the nucleus undergoes a radiative transition after K-capture it should be feasible to investigate the correlation between the circular polarizations of the X-ray and nuclear quanta. If the atomic shell vacancy is due to a conversion transition, information on nuclear level moments and parities can be obtained by observing polarization correlation of the X-ray quanta. The polariaation of $\beta$-electrons and $\gamma$-quanta in a complex cascade transition is also considered. A.

539.166.74

7349. PHOTON SCATTERING FROM PROTONS AND DEUTERONS. R.H.Capps.
Phys. Rev., Vol. 106, No. 5, 1031-42 (June 1, 1957).

The scattering of photons of 100 to 200 MeV from protons and deuterons is examined in a model in which it is assumed that only electric and magnetic dipole photons scatter. Two dispersion relations derived by Gell—Mann, Goldberger, and Thirring, and the analysis of photopion production from nucleons by Watson, Keck, Tollestrop, and Walker, are used to guide the theoretical prediction of differential scattering cross-sections. Several approximations are made, including the impulse approximation in the discussion of photon—deuteron scattering; the accuracy of these approximations is estimated. In this model the photon—proton cross-section, and the sum of the elastic and inelastic photon-deuteron cross-sections are largest at backward scattering angles. Several feasible types of photon—deuteron scattering experiments are discussed briefly. A.

539.166.74

7350. ANGULAR CORRELATIONS IN THE TWO-PHOTON COMPTON EFFECT. R.B.Theus and L.A.Beach.
Phys. Rev., Vol. 106, No. 6, 1249-52 (June 15, 1957).

The angular correlation between the two photons emitted in two-photon Compton scattering of $Co^{60}$ gamma-radiation was observed to be in good agreement with theoretical predictions. Coincidence data was obtained for scattering angles of $40^0$ and $60^0$ as a function of the azimuthal angle between the two scattered photons. A.

539.166.74

7351. SMALL-ANGLE ELASTIC SCATTERING OF $\gamma$-RAYS. H.Schopper.
Z. Phys., Vol. 147, No. 3, 253-60 (1957). In German.

The scattering of 325 ($Cr^{51}$) and 660 keV ($Cs^{137}$) $\gamma$-rays was measured for scattering angles between 2.5 and $20^0$, using scatterers of Pb, Cu and Al. A.O.Stanesby

539.166.75 : 537.531.7

THE X-RAY AND $\gamma$-RAY ABSORPTION COEFFICIENTS OF A NUMBER OF GLASSES. See Abstr. 7143

539.166.83

7352. INTERNAL CONVERSION COEFFICIENTS FOR M1 TRANSITIONS IN $_{83}Bi^{214}$, $_{84}Po^{214}$ AND $_{83}Bi^{212}$. K.O.Nielsen, O.B.Nielsen and M.A.Waggoner.
Nuclear Physics, Vol. 2, No. 4, 476-84 (Dec., 1956).

Measurements on internal conversion lines of $Bi^{214}$ confirm that the experimental M1 internal conversion coefficients for heavy elements are considerably smaller than the values calculated for a point nucleus. The results are in approximate agreement with the finite size corrected values of Sliv and Band. A number of transitions in $Po^{214}$ with $\Delta I = 0$ or 1 were found to be mainly M1 according to conversion coefficients corrected for finite size effects. The tables of uncorrected conversion coefficients would have indicated the systematic occurrence of large E2 admixtures. The K/L ratio for the 115 keV M1 transition in $Bi^{212}$ was found to agree with the theoretical value, which is not sensitive to the finite size effect. This ratio was earlier thought to be abnormally low. A.

539.166.83

7353. ON THE THEORY OF CONVERSION COEFFICIENTS. G.Kramer.
Z. Phys., Vol. 147, No. 5, 628-35 (1957). In German.

A correction is reported to the formula for the electric conversion coefficient given previously (Abstr. 674/1957). This leads to a consideration of the connection between the electron—nucleon interaction equations and Hume's retarded interaction operator. The case of a point interaction is discussed in some detail. J.W.Gardner

539.166.835

7354. ANGULAR CORRELATION OF ANNIHILATION RADIATION FROM ORIENTED GRAPHITE. S.Berko, R.E.Kelley and J.S.Plaskett.
Phys. Rev., Vol. 106, No. 4, 824-5 (May 15, 1957).

The standard experimental method was used and the angular distribution found to be bimodal compared with the bell-shaped curve for polycrystalline graphite. It is shown that the shapes of the two distributions can be given by adding the theoretical contributions of the $\sigma$- and $\pi$-electrons in the ratio $\pi/\sigma = 1.82/2.18$. E.J.Burge

# NUCLEAR REACTIONS 539.17

539.17 : 523.11

7355. NUCLEAR REACTIONS IN THE LATER STAGE OF THE STELLAR EVOLUTION. K.Nakagawa, T.Ohmura, H.Takebe and S.Obi.
Progr. theor. Phys., Vol. 16, No. 4, 389-415 (Oct., 1956).

Nuclear reactions induced by helium capture, $3\alpha \rightarrow C^{12} + \gamma$ etc., are investigated. The results are applied to the study of the variation of chemical abundances and the energy generation in the hydrogen-exhausted stellar core with suitable physical conditions. The reactions, $C^{12} + C^{12}$ etc., are also discussed. The results obtained are useful to study the stellar evolution in its later stage. A.

539.17 : 523.877

7356. HELIUM CAPTURING REACTIONS IN STARS. S.Hayakawa, C.Hayashi, M.Imoto and K.Kikuchi.
Progr. theor. Phys., Vol. 16, No. 5, 507-27 (Nov., 1956).

The generation of $C^{12}$, $O^{16}$ and $Ne^{20}$ by successive $\alpha$-capturing processes in the helium core of stars is calculated under the condition at temperature $\sim 10^8$ $^0$K. The rates of forming $C^{12}$ and $Ne^{20}$ are found to be much larger than the previous calculations by Salpeter, Öpik and Hoyle, due to the resonance levels recently discovered. The production rates of $Mg^{24}$ and $Ca^{40}$ are also estimated. The formation of these nuclei is found to be negligible at temperatures below $4 \times 10^8$ $^0$K. The luminosity of such stars of globular clusters belonging to the horizontal branch in the H—R diagram that are supposed to be burning helium is accounted for in terms of the above thermonuclear reactions at the central temperature of $(1.40 \pm 0.10) \times 10^8$ $^0$K and the density of about $10^3$g cm$^{-3}$. The lifetime of a star in this evolutionary stage is estimated roughly as $10^7$ years. In this course of evolution $Ne^{20}$ is formed more abundantly than others, in disagreement with the average cosmic abundances of $C^{12}$, $O^{16}$ and $Ne^{20}$. Modification of the abundances after this stage is suggested as necessary. A.

539.17 : 523.112

7357. FORMATION OF LIGHT NUCLEI IN THE EXPANDING UNIVERSE. C.Hayashi and M.Nishida.
Progr. theor. Phys., Vol. 16, No. 6, 613-24 (Dec., 1956).

The building up of light nuclei up to $Ne^{20}$ out of initial protons and neutrons in the early stage of the expanding universe is studied, taking account of the $\alpha$-capture reactions. Taking matter density $\rho_m = 10^6 - 10^7$ g/cm$^3$ at $T = 10^{10}$ $^0$K, the relative abundance of hydrogen, helium and oxygen obtained is consistent with present observation. The possibility of forming heavier nuclei is discussed. A.

539.172

7358. CALCULATION OF CROSS-SECTIONS FOR ABSORPTION OF HIGH ENERGY PARTICLES BY NUCLEI. G.Philbert.
C.R. Acad. Sci. (Paris), Vol. 244, No. 12, 1634-6 (March 18, 1957). In French.

The experimental data on the charge distribution in nuclei are used in calculating the absorption cross-sections for nucleons and pions of energies greater than 1 GeV. Numerical results are presented for a number of light and heavy elements. L.L.Green

539.172

7359. THERMONUCLEAR POWER: A THEORETICAL INTRODUCTION. W.B.Thompson.
Nature (London), Vol. 179, 886-9 (May 4, 1957).

Discusses briefly the nuclear reactions, thermonuclear reaction rates, necessary conditions in the core of a power-producing reactor, and the magnetic fields required to isolate such a core from any material walls. The use of a self-constricted gas discharge is a promising method marred, however, by instabilities. See Abstr. 3620-1 (1957). R.S.Pease

539.172

7360. EXTERNAL COULOMB FIELDS IN THE WIGNER–EISENBUD NUCLEAR REACTION THEORY.
G.Breit and J.S.McIntosh.
Phys. Rev., Vol. 106, No. 6, 1246-8 (June 15, 1957).

The Wigner–Eisenbud $\mathcal{R}$ matrix treatment of nuclear reaction theory is generalized to allow for Coulomb interactions in the channels and pertinent explicit relations are given. A.

539.172

7361. CROSS-SECTION MEASUREMENT NEAR 50 BeV.
A.E.Brenner and R.W.Williams.
Phys. Rev., Vol. 106, No. 5, 1020-5 (June 1, 1957).

An experiment to measure the cross-section for high-energy cosmic-ray protons and neutrons to interact with the Fe nucleus has been carried out at 3250 m elevation. The detector had a relatively good energy resolution, and was designed to select nucleons in the vicinity of 50 BeV. The purpose was to obtain a single interaction cross-section with good accuracy in order to compare it with results obtained with accelerators in the 1 to 5 BeV region. This comparison yields a value for the elementary meson-production cross-section [the average of $\sigma(pp)$ and $\sigma(np)$] near 50 BeV. The Fe results are: neutrons, $\sigma_{Fe} = 0.61 \pm 0.03$ barn; protons, $\sigma_{Fe} = 0.61 \pm 0.04$ barn. The corresponding average nucleon–nucleon "inelastic" (presumably meson production) cross-section is $\sigma_{nucleon} = 21 \pm 4$ millibarns. A.

539.172

7362. NUCLEAR INTERACTIONS OF COSMIC RAYS IN ALUMINUM. W.W.Brown.
Phys. Rev., Vol. 106, No. 5, 1025-6 (June 1, 1957).

A method is described in which cosmic-ray nuclear interactions occurring in thin aluminium foils and argon gas within a cloud chamber can be detected and the tracks of the emitted charged particles observed. The observed ratio of the number of nuclear interactions per atom of argon to that of aluminium is $1.4 \pm 0.2$, in agreement with the ratio of the nuclear areas of these atoms, 1.3 A.

539.172

NUCLEAR REACTIONS DUE TO COSMIC RAYS. See also under "Cosmic rays". Decimal classification 537.591.8

539.172

7363. EFFECT OF THE EXCLUSION PRINCIPLE ON THE INTERACTION OF K MESONS WITH NUCLEI. R.M.Sternheimer.
Phys. Rev., Vol. 106, No. 5, 1027-30 (June 1, 1957).

An expression is obtained for the reduction of the effective cross-section of K-mesons in a nucleus as a result of the exclusion principle. It is shown that this effect becomes important for incident K-meson energies below ~200 MeV. A.

539.172

7364. NEUTRON PRODUCTION BY $\mu$ MESONS WHICH PENETRATE LEAD.
B.F.Stearns, D.R.Jones, J.K.dePagter and R.D.Sard.
Phys. Rev., Vol. 106, No. 5, 1043-8 (June 1, 1957).

The mean product of cross-section and multiplicity ($\langle\sigma m\rangle$) for evaporation neutrons produced when fast cosmic-ray $\mu$-mesons traverse a Pb producer has been measured. A magnet cloud chamber above the producer and a hodoscope-absorber array below it serve to identify $\mu$-mesons; neutron-producing events are selected by the detection of a delayed coincidence of a thermalized neutron with a penetrating particle. $\langle\sigma m\rangle = (22 \pm 8) \times 10^{-29}$ cm$^2$/nucleon. Theoretical calculations based on experimental photoneutron yields give $\langle\sigma m\rangle = 15 \times 10^{-29}$ cm$^2$/nucleon for the yield due to knock-on showers, and $\langle\sigma m\rangle = 9 \times 10^{-29}$ cm$^2$/nucleon for the direct yield from equivalent photons of the $\mu$-meson field. This theory also agrees with the results of underground measurements at higher average momenta. There is no evidence of $\mu$-meson scattering in excess of Coulomb scattering. Protons which suffer nuclear interactions produce more than 50 neutrons, but seldom produce penetrating secondaries. A.

539.172

7365. SCATTERING OF HIGH ENERGY ELECTRONS BY CARBON AND THE NUCLEAR DENSITY DISTRIBUTION.
L.J.Tassie.
Austral. J. Phys., Vol. 9, No. 3, 400-3 (Sept., 1956).

Distribution of 187 MeV electrons, elastically scattered from $C^{12}$, obtained in the following ways, are compared: (a) the author's results, calculated using the Born approximation and the independent particle model with spherical box and harmonic oscillator wavefunctions (Abstr. 6148/1956); (b) results obtained using the nuclear density distribution of Gatha, Shah and Patel (Abstr. 11317/1954); (c) experimental results of Fregeau and Hofstadter (Abstr. 9832/1955). Curve (b) does not give a good fit with experiment. The nuclear charge distributions corresponding to (a) are similar, but differ considerably from the density distribution (b). Gatha, Shah and Patel have: (i) used a complex potential in the Born approximation and, (ii) assumed that the nuclear scattering potential and density distribution have the same shape. It is pointed out that, whilst procedure (i) is unsatisfactory for scattering by the imaginary part, it should lead to the correct shape of scattering potential. Also, (ii) is only valid if the finite range of internucleon forces may be neglected; however, an attempt to make some allowance for the effect leads to an increased peak in the nucleon distribution at $r = 0$, and fails to correct for the discrepancy. Moreover, due to this effect there is an apparent anomaly in the shapes of nucleon distribution for light nuclei indicated by high-energy electron and nucleon scattering experiments. N.M.King

539.172.1

7366. STUDY OF THE TRANSMUTATION OF COPPER BY NITROGEN AND OXYGEN. J.Beydon, R.Chaminade, M.Crut, H.Faraggi, J.Olkowsky and A.Papineau.
Nuclear Physics, Vol. 2, No. 5, 593-618 (Jan., 1957). In French.

The transmutations of Cu bombarded by N and O ions are studied both for natural Cu and for the separated isotopes $Cu^{63}$ and $Cu^{65}$. Most reactions take place through fusion of the colliding nuclei. New $\gamma$-rays: $Se^{72}$, 50 keV, $T \cong 10$ d; $Br^{75}$, $285 \pm 5$ keV, $T \cong 95 \pm 5$ min; $Br^{74}$, $640 \pm 10$ keV, $T \cong 42 \pm 5$ min. New isotope: $Rb^{79}$, $\beta^+$ emitter, $T = 24 \pm 1$ min, at least one $\gamma$-ray of 150 keV. A.

539.172.1

7367. TRANSMUTATION OF COPPER BY CARBON, OXYGEN AND NEON. H.Atterling, J.Beydon, M.Crut and J.Olkowsky.
Nuclear Physics, Vol. 2, No. 5, 619-23 (Jan., 1957). In French.

Transmutations of Cu bombarded by C, O and Ne ions are studied. Most reactions take place through fusion of the colliding nuclei. A.

539.172.11 : 539.164.74

7368. ELASTIC SCATTERING OF ALPHA PARTICLES WITH THE OPTICAL MODEL. W.B.Cheston and A.E.Glassgold.
Phys. Rev., Vol. 106, No. 6, 1215-19 (June 15, 1957).

The scattering of medium-energy alpha-particles by nuclei has been examined with the optical model. It is possible to reproduce the detailed features of the experimental data with such a model. An examination of the approximate models suggested by other authors is presented. Some features of the data can be understood on the basis of a one-parameter "black" nucleus model (i.e., the Blair model) interpreted quantum-mechanically. However, the requirement of detailed fit to the experimental data requires a model with more parameters. The "blackness" of nuclear matter to alpha particles causes the scattering cross-section to be insensitive to the real part of the alpha-particle–nucleus interaction. A.

539.172.13 : 539.172.4

7369. INELASTIC SCATTERING OF FAST NUCLEONS BY LIGHT NUCLEI. I. BORN APPROXIMATION.
P.Benoist, C.Marty and P.Meyer.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1893-5 (April 1, 1957). In French.

The angular distribution of nucleons scattered inelastically with excitation of the first excited state of the target nucleus is calculated assuming a direct interaction mechanism for incident nucleon energies of several hundred MeV. The particular case of scattering with excitation of the 4.43 MeV state of $C^{12}$ is considered. L.L.Green

539.172.13 : 539.152.1

$Na^{23}$–PROTON REACTIONS. See Abstr. 7293

539.172.13 : 539.163.1

7370. SPALLATION OF MEDIUM WEIGHT ELEMENTS.
G.Rudstam.
Gustaf Werner Institute for Nuclear Chemistry, University of Uppsala (1956) 168 pp.

The cross-sections for spallation products have been measured for vanadium, manganese, cobalt and arsenic irradiated with 170 MeV protons and in the case of arsenic also with 103 and 49 MeV protons. Determinations of half-lives of products have been made. A theoretical study of the nucleon cascades produced in target nuclei by high-energy protons has been carried out using a Monte Carlo method and a study of the de-excitation of the excited nuclei by

evaporation of different particles has been made also by a Monte Carlo method. A combination of the cascade and evaporation calculations has been used to obtain the absolute cross-sections of spallation products. These have been compared with the experimentally determined cross-sections and good agreement is obtained.
L.L.Green

539.172.13

7371. EXCITATION CURVES FOR THE REACTIONS $O^{18}(p,n)F^{18}$ AND $O^{18}(p,\alpha)N^{15}$ FOR PROTONS OF 2.6 TO 4.3 MeV.
D.Szteinsznaider, M.Roclawski-Conjeaud and V.Naggiar.
C.R. Acad. Sci. (Paris), Vol. 244, No. 4, 445-7 (Jan. 21, 1957). In French.

Curves measured at 90° to the proton beam are presented, and show resonances for both $\alpha$ and neutron emission at 3.8 MeV. This observation is not consistent with the suspected T = 3/2 character of the 11.5 MeV level of $F^{19}$ (see Abstr. 5378/1956). J.J.Wilkins

539.172.13 : 539.18

7372. PRODUCTION OF HEAVY MESONS AND HYPERONS BY PROTONS ON DEUTERIUM VIA SECONDARY PIONS.
E.C.Fowler, H.D.Taft and E.R.Mosburg.
Phys. Rev., Vol. 106, No. 4, 829 (May 15, 1957).

A calculation of the cross-sections for producing the various "strange" particles in collisions of 3.0 BeV protons with deuterons, assuming that production takes place only through an intermediate pion. Experimental cross-sections for pion production and strange particle production by pions are used, and the "shading" effect of one nucleon on the other in the deuteron is taken into account.
J.W.G.Wignall

539.172.13

7373. INELASTIC PROTON SCATTERING AND (p,d) REACTIONS IN HEAVY ELEMENTS. B.L.Cohen and S.W.Mosko.
Phys. Rev., Vol. 106, No. 5, 995-1000 (June 1, 1957).

A previous study (Abstr. 4714/1057) of anomalous inelastic scattering is extended to include heavy elements, higher excitation energies of the final nucleus, and deuterons from (p,d) reactions. The energy distributions of protons inelastically scattered from each of the principal isotopes of lead and from bismuth are very similar; there are seven relatively well-defined groups with the same energy, cross-section, and angular distribution. All elements studied with atomic number above 40 have prominent groups with $E_p - E_{p'} \cong 2.5$ MeV. The deuteron energy distributions from (p,d) reactions in Bi and Pb isotopes are very similar (five prominent groups with the same energy and similar cross-sections) in spite of differing Q-values. There are also strong similarities in the deuteron spectra from Au and Pt, and from Pd and Ag. A.

539.172.13 : 539.166.2

7374. INVESTIGATION OF THE GAMMA RADIATION PRODUCED BY IRRADIATING $B^{10}$ WITH PROTONS IN THE ENERGY RANGE 0.7 TO 3.0 MeV. S.E.Hunt, R.A.Pope and W.W.Evans.
Phys. Rev., Vol. 106, No. 5, 1012-15 (June 1, 1957).

The proton beams from a pressurized Van de Graaff accelerator were used to irradiate targets of separated $B^{10}$ isotopes, and the $\gamma$-ray spectra and yield curves from the $B^{10}(p,\alpha\gamma)Be^7$, $B^{10}(p,\gamma)C^{11}$ and $B^{10}(p,p'\gamma)B^{10}$ reactions were measured by using a large crystal spectrometer and pulse-height analyser. The 0.43 ± 0.015 MeV $\gamma$-ray from the $B^{10}(p,\alpha\gamma)Be^7$ reaction was found to have a resonance at 1.540 ± 0.005 MeV, the cross-section at resonance being 80 ± ± 40 millibarns. The 9.70 ± 0.15 MeV radiation from the $B^{10}(p,\gamma)C^{11}$ reaction exhibited a single resonance at 1.146 ± 0.005 MeV, the cross-section at resonance being measured as 5.5 ± 2 microbarns. $\gamma$-rays of about one-twentieth of this intensity of energy about 4.2 MeV and 5.5 MeV can also be attributed to this resonance. The yield of 0.71 ± 0.015 MeV radiation from the $B^{10}(p,p'\gamma)B^{10}$ increased monotonically with energy. The cross-section at 2.7 MeV was 11 ± 5 millibarns. For proton energies of greater than 2.4 MeV, weaker $\gamma$-rays of energy 1.00 ± 0.04 MeV and 2.12 ± 0.06 MeV were also present.
A..

539.172.13

7375. Q-VALUE MEASUREMENTS FOR ALUMINUM AND CHLORINE. D.M.Van Patter, W.C.Porter and M.A.Rothman.
Phys. Rev., Vol. 106, No. 5, 1016-19 (June 1, 1957).

Nuclear reaction energies have been measured by using a 180° double-focusing magnetic spectrometer. In order to test the reliability of the energy calibration of the spectrometer two $Al^{27}(p,\alpha)Mg^{24}$ groups were observed, with measured Q-values of 1.596 ± 0.006 and 0.230 ± 0.005 MeV, corresponding to the ground state of $Mg^{24}$ and the first excited state at 1.366 ± 0.006 MeV. A further check was provided by the observation of six $Al^{27}(p,p')Al^{27}$ inelastic groups, corresponding to $Al^{27}$ levels at 0.842 ± 0.003, 1.013 ± 0.003, 2.205 ± 0.004, 2.727 ± 0.004, 2.975 ± 0.004 and 2.998 ± 0.004 MeV. In view of the good agreement of these results with previous measurements, the ground-state Q-values of the $Cl^{35}(p,\alpha)S^{32}$ and $Cl^{37}(p,\alpha)S^{34}$ reactions have been remeasured as 1.860 ± 0.005 and 3.028 ± 0.006 MeV. A.

539.172.13 : 537.534.74

7376. PROTON–NUCLEUS ELASTIC SCATTERING AT 9.8 MeV.
N.M.Hintz.
Phys. Rev., Vol. 106, No. 6, 1201-6 (June 15, 1957).

The differential cross-section for proton–nucleus elastic scattering has been measured for Li, N, Al, A, Ni, Cu, Ag, Sn, and Au at a laboratory proton energy of 9.8 MeV. Data were taken at 5° intervals from 15° to 170° with an estimated standard deviation of 3 to 5%. The 24 inch diameter scattering chamber is described. The protons are detected by a NaI:Tl crystal whose energy resolution was about 2.5% so that in almost all cases inelastic protons were rejected. The data for Al, A, Ni, Cu, Sn, and Au have been analysed by using the optical model with the Saxon potential. Good fits are obtained for a radius constant $r_0 = 1.20$ in the formula $R = r_0 A^{1/3} \times 10^{-13}$ cm and a real well-depth of 62 MeV for most elements. The imaginary well-depth and the smoothing parameter are A-dependent. A brief discussion is given on the determination of nuclear radii from elastic scattering and nuclear reaction cross-sections. A.

539.172.13 : 537.534.74

7377. ANALYSIS OF PROTON–NUCLEUS SCATTERING AT 9.8 MeV.
A.E.Glassgold, W.B.Cheston, M.L.Stein, S.B.Schuldt and G.W.Erickson.
Phys. Rev., Vol. 106, No. 6, 1207-14 (June 15, 1957).

Studies of nuclear scattering from an arbitrary complex central potential have been initiated. This first report is devoted to the analysis of proton–nucleus scattering at 9.8 MeV using the Saxon potential. Qualitative rules for the dependence of the cross-section on the parameters of this model are presented for medium-heavy elements. An important feature of the analysis is that more than one set of optical model parameters is possible at this energy. These multiple solutions have in common approximately the same value of $VR^2$, where V is the real part of the nuclear potential and R is the interaction radius. This value does not differ significantly from the value used in the nuclear shell model. The imaginary part of the nuclear potential corresponds to an absorption length of about one nuclear radius. A.

539.172.13 : 539.152.1

7378. ANGULAR CORRELATIONS IN THE $F^{19}(p,\alpha\gamma)O^{16}$ REACTION.
H.J.Martin, W.A.Fowler, C.C.Lauritsen and T.Lauritsen.
Phys. Rev., Vol. 106, No. 6, 1260-5 (June 15, 1957).

Angular correlation patterns in the $F^{19}(p,\alpha\gamma)O^{16}$ reaction, between alpha-particles leading to the 6.13 MeV excited state of $O^{16}$ and the corresponding gamma-rays, have been measured for proton bombarding energies of 873, 935, 1250, 1280, 1346 and 1372 keV. The patterns confirm earlier spin and parity assignments and permit quantitative determination of the relative importance of high orbital angular momenta in the formation and decay of $Ne^{20}$ states. In two cases, the higher l-values participate much more strongly than might be expected from elementary barrier considerations. A.

539.172.13

7379. ANGULAR DISTRIBUTION OF $\alpha$-PARTICLES FROM $^7Li(d,\alpha)^5He$. A.C.Riviere and P.B.Treacy.
Austral. J. Phys., Vol. 10, No. 1, 209-13 (March, 1957).

The angular distribution has been measured at a deuteron energy of 900 keV. It is concluded that the angular distribution of the $\alpha$-particles leading to the formation of the ground state of $He^5$ is isotropic at this bombarding energy. L.L.Green

539.172.13

7380. DETERMINATION OF $\gamma$ TRANSITIONS IN THE REACTION $Mg^{24}(d,p)Mg^{25*}(\gamma)Mg^{25}$.
S.Gorodetzky, M.Port, T.Muller and G.Bergdolt.
C.R. Acad. Sci. (Paris), Vol. 244, No. 15, 2041-4 (April 8, 1957). In French.

Results of p,$\gamma$ coincidence measurements are reported. A decay scheme covering the first four excited levels of $Mg^{25}$ is presented. J.J.Wilkins

539.172.13

7381. THE REACTIONS (d,p), (d,n) AND THE "STRIPPING" MECHANISM. I. THEORY. J.Horowitz.
Cahiers de Phys., No. 73, 1-8 (Sept., 1956). In French.

A review of the theoretical interpretation of stripping reactions. The theory of Butler is outlined and later modifications and additions are considered. The absolute cross-sections, the magnitude of the reduced widths, the importance of the stripping reaction near a resonance of the compound nucleus and the polarization of the emitted nucleons in the (d,p) and (d,n) reactions are briefly discussed.
D.J.A.Prowse

539.172.13

7382. THE REACTIONS (d,p), (d,n) AND THE STRIPPING MECHANISM. II. EXPERIMENTS AND RESULTS. E.Cotton.
Cahiers de Phys., No. 73, 9-21 (Sept., 1956). In French.

For Pt I, see preceding abstract. A historical review of experiments on stripping reactions. The discovery of the importance of stripping in nuclear reactions is traced from the early work of Oppenheimer and Phillips and the early Liverpool work on angular distributions using 8 MeV deuterons in 1949 up to the present time when angular distributions of very close doublets are measured by the M.I.T. group. The results obtained on the size of the nuclear radius from the best theoretical fit to the experimental data are discussed and the recent extensions of the stripping mechanism to (p,n), (p,p') and (p,$\alpha$) reactions are briefly considered.
D.J.A.Prowse

539.172.13

7383. DIFFRACTIONAL SCATTERING OF FAST DEUTERONS BY NUCLEI. A.I.Akhieser and A.G.Sitenko.
Phys. Rev., Vol. 106, No. 6, 1236-46 (June 15, 1957).

The elastic scattering cross-section $\sigma_e$ and the diffractional disintegration cross-section $\sigma_d$ for fast deuterons incident on absolutely black nuclei are determined, and the energy spectrum of the disintegration products is found. For $R \gg R_d \gg \lambda$ [where R and $R_d$ are the radii of the nucleus and of the deuteron, respectively, and $\lambda$ is $(2\pi)^{-1}$ times the wavelength of the deuteron], the cross-sections are $\sigma_e = \pi R^2 + \frac{2}{3}\pi(1 - \ln 2)RR_d$ and $\sigma_d = \frac{1}{3}\pi(2\ln 2 - \frac{1}{2})RR_d$ The total cross-section for all processes (including the stripping and the absorption of the deuteron) is $\sigma_t = 2\pi R^2 + \pi RR_d$. The disintegration cross-section for fast deuterons, taking into account the diffraction and the Coulomb interaction, is found. If the nucleus is absolutely black and if $R \gg R_d$, there is no interference between the diffractional disintegration and the disintegration due to the Coulomb interaction. If in this case $n = Ze^2/\hbar v \ll 1$ (where v is the velocity of the deuteron), the disintegration cross-section due to the Coulomb interaction is a small correction to the diffractional disintegration cross-section. If $n \gg 1$ and $E \gg B$ (where E is the energy of the deuteron and B is the height of the Coulomb barrier), the disintegration cross-section can also be found; in this case it is determined mainly by the Coulomb interaction and is $\sigma_f = (4\pi/3)n^2R_d^2 \ln(R_d/\lambda)$. Expressions are found for the elastic scattering cross-section for a deuteron, taking into account the semitransparence of the nuclei.
A.

539.172.13

7384. DEUTERON STRIPPING AND THE COMPOUND NUCLEUS. M.Nagasaki.
Progr. theor. Phys., Vol. 16, No. 5, 429-46 (Nov., 1956).

Deuteron stripping (d,p) reactions are investigated as corrections to the ordinary formal theories of nuclear resonance reactions, based on the compound nucleus model, in which the decaying tails of the internal wave-functions of various reaction products are neglected. The amplitude for a (d,p) stripping reaction is shown to be due to the overlapping of the decaying tail of the deuteron internal wave-function and the wave-function of the neutron trapped in the target nucleus. It differs from Butler's stripping amplitude in that the contributions from the configurations in which the proton is within the range of the interaction between the proton and the target nucleus or between the proton and the neutron interacting with the target nucleus, are properly included in the amplitude for the (d,p) reaction due to the formation and the subsequent decay of the compound nucleus. The effects of the compound nucleus formation on the angular distribution of emerging protons are also discussed in connection with the interpretations of some phenomenological calculations previously presented. As the formulation is given in a general way, it can be applied also to other cases such as (p,d) pick-up, (n,p) direct or (t,d) stripping reactions.
A.

539.172.13 : 539.152.1 : 539.165.2

$Mo^{96}(p,n)Tc^{95}$ REACTION. See Abstr. 7338

539.172.13

7385. NEUTRON SPECTRUM FROM T + t.
S.J.Bame, Jr and W.T.Leland.
Phys. Rev., Vol. 106, No. 6, 1257-9 (June 15, 1957).

The energy spectrum of neutrons from the T + t reactions has been measured at 0° for a triton energy of 1.48 MeV. The energies of the neutrons extend from 0 to 12 MeV. A peak at the high-energy end at 11.3 MeV is ascribed to the $T(t,n)He^5$ reaction. No other peaks are observed within the counting statistics of the experiment.
A.

539.172.3 : 539.185

7386. POLARISATION OF NUCLEONS FROM PHOTO-DISINTEGRATION OF DEUTERON. I. MEDIUM ENERGIES. W.Czyż and J.Sawicki.
Bull. Acad. Polon. Sci. Cl. 3, Vol, 4, No. 8, 515-19 (1956).

The polarization is calculated assuming the n–p system interacts through a potential containing a tensor term. Three types of exchange force were considered, "symmetrical", "charged" and "neutral". The maximum value of the polarization obtained for these interactions were, −20%, −14% and +6% respectively. It is suggested that a measurement of the polarization in both magnitude and direction would give valuable information on the type of interaction involved.
D.J.A.Prowse

539.172.3

7387. MEASUREMENT OF THE ELASTIC SCATTERING OF 1.33 MeV $\gamma$-RAYS IN TIN. E.Hara, J.Banaigs and J.Mey.
C.R. Acad. Sci. (Paris), Vol. 244, No. 16, 2155-7 (April 15, 1957). In French.

Differential cross-sections for scattering angles of 30° to 120° are reported, and are in accord with theoretical values for Rayleigh and Thomson scattering. No evidence for scattering by the nuclear electric field is obtained.
J J.Wilkins

539.172.3

7388. THE $(\gamma,n)$ REACTION IN $Be^9$ AT INTERMEDIATE ENERGIES. R.D.Edge.
Nuclear Physics, Vol. 2, No. 4, 485-95 (Dec., 1956).

Cross-sections for the reaction $Be^9(\gamma,n)Be^8$ for monochromatic gamma-rays in the energy range 2.6 to 8.1 MeV have been obtained using a large Szilard–Chalmers neutron detector. At energies of 2.61, 4.4, 6.2 and 8.1 MeV they are $(3.77 \pm 0.2) \times 10^{-28}$ cm$^2$, $(1.86 \pm 3.6) \times 10^{-28}$ cm$^2$, $(11.4 \pm 1.0) \times 10^{-28}$ cm$^2$ and $(13.8 \pm 1.6) \times 10^{-28}$ cm$^2$ respectively. The implications of these results for current theories of the reaction are discussed.
A.

539.172.3

7389. SUM RULES FOR PHOTODISINTEGRATION OF $H^3$ AND $He^3$. M.L.Rustgi.
Phys. Rev., Vol. 106, No. 6, 1256-7 (June 15, 1957).

The sum rules of Levinger and Bethe (Abstr. 6066/1950) are applied to calculate the dipole bremsstrahlung weighted cross-section ($\sigma_b = \int_0^\infty (\sigma/W)dW$) and the integrated cross-section ($\sigma_{int} = \int_0^\infty \sigma dW$) for $H^3$ and $He^3$ using Irving's wave-function. On assuming charge symmetry and neglecting Coulomb repulsion, it is found that $\sigma_b(H^3) = \sigma_b(He^3)$ and $\sigma_{int}(H^3) = \sigma_{int}(He^3)$.
A.

539.172.3

7390. DIRECT EXCITATION IN THE PHOTODISINTEGRATION OF TANTALUM ABOVE THE GIANT RESONANCE.
J.H.Carver, R.D.Edge and K.H.Lokan.
Proc. Phys. Soc. A, Vol. 70, Pt 6, 415-20 (June, 1957).

The bremsstrahlung from the Canberra electron-synchrotron has been used to measure the single and multiple photoneutron yields of tantalum from the thresholds to 31 MeV. The ratio of the total integrated cross-section for the $(\gamma,n)$ reaction to that for the $(\gamma,2n) + (\gamma,3n)$ reactions is found to be

$$\int_0^{31} \sigma_1 dE \Big/ \int_0^{31} (\sigma_2 + \sigma_3)dE = 2.6 \pm 0.3.$$

For gamma-rays of energy exceeding about 17 MeV significant contributions to $\sigma_1$ can only come from direct interactions, and the ratio of the integrated cross-sections in this region is found to be

$$\int_{17}^{31} \sigma_1 dE \Big/ \int_{17}^{31} (\sigma_2 + \sigma_3)dE = 0.86 \pm 0.15.$$

The results show that direct interactions account for a large part of the photon absorption in the high-energy tail above the giant resonance.
A.

539.172.3

7391. PROTONS EJECTED FROM NICKEL BY 17.5 MeV BREMSSTRAHLUNG. B.M.Spicer, E.G.Muirhead and G.C.Shute.
Austral. J. Phys., Vol. 10, No. 1, 217-20 (March, 1957).

The photoprotons ejected from nickel by $\gamma$-rays of energy below the peak of the ($\gamma$–p) giant resonance have been investigated. The bremsstrahlung from 17.5 MeV electrons was used and the distribution in energy and angles of the photoprotons measured. The energy distribution is shown to be consistent with an evaporation model. The angular distributions are reported to be consistent with isotropy although the authors draw attention to possible peaks at $50^0$ and $120^0$. L.L.Green

539.172.3

7392. ON THE CALCULATION OF THE CROSS-SECTIONS OF PHOTONUCLEAR REACTIONS INDUCED BY BREMSSTRAHLUNG. G.Boulègue.
C.R. Acad. Sci. (Paris), Vol. 244, No. 7, 881-4 (Feb. 11, 1957). In French.

The method of calculation described is based on an empirical formula for the bremsstrahlung spectrum. J.J.Wilkins

539.172.4 : 539.163.2

7393. AN EXPERIMENTAL STUDY OF NEUTRON INDUCED ACTIVITIES IN WATER. N.Faull.
Atomic Energy Res. Establ. (Harwell) Rep. R/R1919, 30 pp. (1957).

The fast neutron reactions $O^{16}(n,p)N^{16}$ and $O^{17}(n,p)N^{17}$ of oxygen (as water) have been studied, with the results given below. The $N^{16}$ produced in the reaction $O^{16}(n,p)N^{16}$ was found to decay with a half-life of 7.2 ± 0.3 seconds, with the emission of $\gamma$-rays of energy 6.2 ± 0.2 MeV, whose absorption coefficient in lead is 0.526 ± ± 0.016 $cm^{-1}$, corresponding to a half-value thickness of 1.32 ± 0.04 cm. The overall attenuation in lead of the 6.2 MeV $\gamma$-rays plus the associated degraded (by scattering) radiation above 2 MeV, can also be characterized, up to an absorber thickness of 9.5 cm, by a single absorption coefficient of value 0.484 ± 0.014 $cm^{-1}$, corresponding to a half-value thickness of 1.43 ± 0.04 cm. Referred to the average thermal flux (which is itself referred to a boron cross-section of 770 barns) in the uranium walls of the uranium hollow slug system within which the water was irradiated, the effective cross-section for the reaction $O^{16}(n,p)N^{16}$ for the emission of 6.2 MeV $\gamma$-ray was found to be 3.0 ± 0.2 microbarns. Since this $\gamma$-ray is reported to be emitted in only about 80% of the $N^{16}$ disintegrations, the actual cross-section for the reaction $O^{16}(n,p)N^{16}$ is 3.8 ± 0.3 microbarns. The $N^{17}$ produced in the reaction $O^{17}(n,p)N^{17}$ was found to decay with a half-life of 4.16 ± 0.15 seconds, with the emission of neutrons. Referred to the same thermal flux as above, the effective cross-section of normal oxygen for this neutron emission was found to be (1.25 ± 0.16) x $10^{-3}$ microbarns. Since $O^{17}$ is reported to be present in normal oxygen to the extent of only 0.03% the actual cross-section for the reaction $O^{17}(n,p)N^{17}$ is 3.2 ± ± 0.4 microbarns. A.

539.172.4 : 518.5

7394. A PROGRAMME FOR SOLVING THE TWO GROUP DIFFUSION EQUATIONS OF CYLINDRICAL REACTORS. A.Hassitt.
Atomic Energy Res. Establ. (Harwell) Mem. No. T/M148, 13 pp. (1957).

The programme solves the two-group diffusion theory equations for almost any type of cylindrical reactor. A Ferranti Mark 1* computer is used. The most general problems take about an hour to solve, unidimensional problems take six minutes. The report gives an outline of the method of solution, and describes in detail the way in which the initial data is to be presented for use by the machine. A.

539.172.4 : 539.152.1

7395. STUDY OF $Al^{27}(n,p)Mg^{27}$ AT 14 MeV.
R.K.Haling, R.A.Peck, Jr and H.P.Eubank.
Phys. Rev., Vol. 106, No. 5, 971-4 (June 1, 1957).

Protons emerging from aluminium foil bombarded by D + T neutrons have been studied with 400$\mu$ emulsions recording over a continuous range of angles from $15^0$ to $165^0$. Groups in the composite energy spectrum correspond to known $Mg^{27}$ levels at 1.0 and 3.5 MeV and suggest additional ones at 1.6, 5.7, and 7.0 MeV. The nuclear "temperature" for the continuous portion of the spectrum is 1.2 MeV. The following cross-sections are tabulated: for each energy group, isotropic and anisotropic total cross-sections and maximum differential cross-section; for all protons over 2 MeV, differential cross-sections at $30^0$ intervals. The isotropic component greatly exceeds the forward-peaked one for each group. Total cross-section for the reaction is estimated to be 79 ± 15 millibarns. A.

539.172.4

7396. CROSS SECTION FOR THE $Be^9(n,\alpha)He^6$ REACTION. P.H.Stelson and E.C.Campbell.
Phys. Rev., Vol. 106, No. 6, 1252-5 (June 15, 1957).

The cross-section for the reaction $Be^9(n,\alpha)He^6$ has been measured for neutron energies of 0.7 MeV (threshold) to 4.4 MeV. The cross-section exhibits a smooth rise from less than 0.1 millibarns at the expected threshold to a broad maximum of 104 ± 7 millibarns at 3.0 MeV, followed by a gradual decrease to 70 millibarns at 4.4 MeV. A.

539.172.4

7397. AN ESTIMATE OF THE TOTAL CROSS-SECTION OF ACCUMULATED FISSION PRODUCTS [IN $U^{235}$]. D.G.Hurst.
Atomic Energy of Canada Rep. 248, 16 pp. (Oct. 18, 1951).

By summing cross-sections of stable and long-lived fission products, using published fission yields and neutron capture cross-sections, $\sigma_p$ the total poison cross-section is calculated to be $\sigma_p = [0.053\,T + 0.0155]\sigma_F$. $\sigma_F$ is the fission cross-section and T is irradiation time measured in units of lifetime of $U^{235}$ in the neutron flux. This formula is valid for $0.1 < T < 1$ and for $U^{235}$ lifetimes of several years, but it ignores some fission products of unknown cross-section (notably $Zr^{93}$, $Tc^{99}$, $Sm^{151}$, $Sm^{147}$) and also the contribution of $Xe^{135}$ R.S.Pease

539.172.4

7398. CALCULATED CROSS-SECTIONS OF IRRADIATED THORIUM. D.G.Hurst and H.Gellman.
Atomic Energy of Canada Rep. 250, 9 pp. (June 5, 1953).

The neutron yield and absorption cross-sections of $Th^{232}$, $U^{233}$ and mixtures thereof are calculated as functions of neutron dose up to 0.005 neutrons per barn for fluxes of $10^{13}$, 3 x $10^{13}$ and $10^{14}$ neutrons per $cm^2$ per sec. Processes considered are:-

$Th^{232} + n \rightarrow Th^{233} \rightarrow Po^{233} + e \rightarrow U^{233} + e$;
$U^{233} + n \rightarrow U^{234}$; $U^{233} + n \rightarrow 2.36\,n$ + fission products;
$U^{234} + n \rightarrow U^{235}$; $U^{235} + n \rightarrow 2.112\,n$ + fission products;
neutron capture in the fission products.

In pure thorium the yield of fission neutrons is calculated to exceed the neutron absorption when more than 7.4 x $10^{-3}$ neutron per $Th^{232}$ atom have been supplied by an external source, at $10^{13}$ neutrons per $cm^2$ per sec. Results for the three fluxes do not differ greatly; the important time constants are the decay times of $Po^{233}$ and $Xe^{135}$. R.S.Pease

539.172.4

7399. CALCULATED CROSS-SECTIONS OF IRRADIATED THORIUM (REVISED). D.G.Hurst.
Atomic Energy of Canada Rep. 364, 9 pp. (Oct., 1956).

Presents cross-sections as in AECL Rep. 250 (see preceding abstract), based on revised data, including neutron capture in $Pa^{233}$, transient effects of $Pa^{233}$ decay, and some allowance for resonance capture in $Th^{232}$ R.S.Pease

539.172.4

7400. THE EFFECTIVENESS OF NEUTRONS AS A FUNCTION OF THEIR ENERGY IN THE NATURAL URANIUM ENVELOPE OF ZEPHYR. H.Rose and R.M.Absalom.
Atomic Energy Res. Establ. (Harwell) Rep. R/R2150, 7 pp. (1957).

The variation of neutron effectiveness with energy has been investigated in the natural uranium envelope of Zephyr. The experiments involved using the reactor in a steady, sub-critical condition, and measuring the relative changes in reactor flux produced by calibrated neutron sources of different mean energies when inserted into the reactor envelope. In all, five photoneutron ($\gamma$,n) and two ($\alpha$,n) sources were used, ranging in average energy from 0.03 MeV to 5.0 MeV. Measurements were carried out at five positions in the uranium envelope, and results obtained for the dependence of neutron effectiveness upon neutron energy and also upon distance from the reactor core. It is shown that the lower energy neutrons (< about 100 keV) in the uranium envelope contribute very little to the reactivity of the Zephyr system. A

539.172.

7401. A TWO ZONE SLURRY REACTOR.
M.F.Duret and I.L.Wilson.
Atomic Energy of Canada Rep. 249, 15 pp. (Nov. 9, 1955).

Calculations were made on a spherical two-zone slurry reactor operated at high temperatures and pressures. Uranium oxide suspended in $D_2O$ fills the outer zone, while the inner contains a similar slurry enriched with plutonium. The critical size, the power density in the two zones and the breeding ratios were calculated for three slurry densities. Later results show that the cross sections used are incorrect but the method of calculation remains valid. R.D.Smi

539.172.4

7402. ATTAINABLE BURN-UP OF URANIUM WITH PLUTONIUM RECYCLING. W.B.Lewis.
Atomic Energy of Canada Rep.285, 13 pp. (Feb. 3, 1956).

A method of analysis, applicable to the equilibrium condition in a thermal reactor which takes account of losses in the recycling of plutonium is developed in detail. It is shown that for a start-up with natural uranium the attainable burn-up in the ANL 1000 MW $D_2O$ boiling reactor is 30 000 megawatt days per tonne. By initial enrichment of the fuel and a reduction in the resonance escape factor from 0.84 to 0.70 the attainable burn-up is increased to 45 000 megawatt days per tonne. R.D.Smith

539.172.4

7403. THE PROBLEM OF FLUX INSTABILITY IN LARGE POWER REACTORS. A.G.Ward.
Atomic Energy of Canada Rep. 345, 9 pp. (July 26, 1956).

The insertion of an absorbing control rod into a thermal reactor operating at high power causes a local depression of the flux and a local increase of xenon poisoning which increases the effect of the insertion of the rod. Under some conditions this effect may result in an instability of the flux distribution inside the reactor. Spatial power oscillations are then possible, even though the total power remains constant. The conditions for such oscillations are considered in detail and it is shown that a light-water-moderated reactor is liable to such oscillations. The NRU reactor is normally stable against continued oscillations, but transient flux distortions may occur. R.D.Smith

539.172.4

7404. EFFECT OF FLUX FLATTENING ON PILE POWER. M.F.Duret and W.J.Henderson.
Atomic Energy of Canada Rep. 347, 11 pp. (July 25, 1956).

The flux distribution in a cylindrical heavy-water reactor consisting of a two-zone core (each zone a lattice of NRU rods) surrounded by an infinite light-water reflector was studied using an electronic analogue computer. By using a smaller lattice spacing in the inner zone the flux is flattened and, for a given maximum power in the hottest fuel rod, the reactor power is increased. The degree of flux flattening is calculated as a function of the radii of the two-core zones and the lattice spacing in the outer zone. Compared with a single-zone core the reactor power may be increased and the fuel inventory decreased, though the neutron leakage also increases. R.D.Smith

539.172.4

7405. RATES OF CONVERGENCE IN NUMERICAL SOLUTION OF THE DIFFUSION EQUATION. R.H.Stark.
J. Assoc. Comput. Mach., Vol. 3, No. 1, 29-40 (Jan., 1956).

A summary is given of experience gained with calculations arising from the problem of extending the use of models for calculating neutron flux and power distribution for the design of nuclear power reactors, to include models not having spherical or cylindrical symmetry. The problem is described and the differential equations and difference approximations obtained. Experimental results and graphical illustrations, are given, of the test problem and the convergence of the power iteratives studied. Computation times are estimated and possibilities for further investigations summarized. A.V.Payne

## ATOM AND MOLECULE BEAMS. MESONS. NEUTRONS 539.18

539.18

7406. CONCERNING THE NUMBER OF DIFFERENT TYPES OF K-MESONS. B.Ioffe, L.Okun and I.Pomeranchuk.
Nuclear Physics, Vol. 2, No. 3, 277-80 (Nov., 1956).

The small-angle scattering cross-sections of K-mesons by deuterons with and without charge exchange are estimated and their bearing on the question of the number of different types of K-mesons discussed. Possible interpretations are examined for the difference of K-meson scattering by free and bound nucleons. A.

539.18

7407. A MODEL OF AN UNSTABLE PARTICLE. V.Glaser and G Källén.
Nuclear Physics, Vol. 2, No. 6, 706-22 (Feb., 1957).

The details of the Lee model are worked out when the mass of the so-called V-particle is larger than the sum of the masses of the N-particle and the $\theta$-particle. In this case the V-particle is unstable and the corresponding eigenstate of the Hamiltonian does not exist. A wave-packet of states with N and $\theta$-particles representing the unstable V-particle is explicitly constructed, and its decay is studied. Throughout this investigation a cut-off is used in the model and the renormalized coupling constant is assumed to be smaller than the corresponding critical value. In this way the complication with "negative probabilities" encountered earlier is avoided. A.

539.18

7408. MODEL OF THE STRONG COUPLINGS. M.Gell-Mann.
Phys. Rev., Vol. 106, No. 6, 1296-1300 (June 15, 1957).

An attempt is made to construct a crude field theory of hyperons and K-particles, which are assumed to have spin ½ and spin 0, respectively. The parity of $\Lambda$ is defined to be plus. Some preliminary experimental evidence is adduced in support of parity plus for $\Sigma$. It is further argued that $\Lambda$ and $\Sigma$ are coupled to $\pi$ with roughly the same coupling constant as in the $\pi-N$ case, while the coupling of K to baryons is weaker. A model of the strong couplings is suggested that incorporates these features. The very strong (VS) pion interactions are completely symmetrical in the baryons, and would leave them all degenerate in the absence of the moderately strong (MS) interactions of K. These last lead to the mass differences among baryons and to the production and absorption of K-particles. The MS coupling constants must be determined by experiment, but the VS interactions are exactly specified. With the MS couplings treated in lowest approximation, it is possible to relate any matrix element for K and hyperon reactions to a corresponding matrix element in the theory of nucleons and pions. Thus in the processes $\overline{K} + p \rightarrow \pi + \Lambda$ and $\overline{K} + p \rightarrow \pi + \Sigma$ it is expected that in the final state the analogue of the (3/2,3/2) resonance of the $\pi-N$ system will be observed. It may be, as Wigner has suggested, that the equality of pion couplings for the baryons is somehow related to the conservation of baryons, and that the analogy with electromagnetic coupling is instructive. A.

539.18

7409. CHIRALITY OF K PARTICLE. S.Watanabe.
Phys. Rev., Vol. 106, No. 6, 1306-15 (June 15, 1957).

In the two-component theory, the neutrino that can exist in nature is characterized by one of the eigenvalues of the "chirality" operator, $\gamma_5$, which anticommutes with the parity operator. The chirality operator is generalized so that it can be applied also to bosons. The K-particle that can exist in nature is characterized by a certain condition on the eigenvalues of the chirality operator. There is strong reason to believe that the chirality quantum number thus introduced is closely related to the strangeness quantum number. A.

539.18

7410. SOME CONSEQUENCES OF THE COMPOUND HYPOTHESIS FOR ELEMENTARY PARTICLES. K.Matumoto.
Progr. theor. Phys., Vol. 16, No. 6, 583-8 (Dec., 1956).

The author derives some consequences of the hypothesis proposed by Sakata for the models of pions and of heavy unstable particles. On the basis of Sakata's model, a semi-empirical mass formula is proposed for these particles, and some interesting results are obtained from this formula. A.

539.18

7411. THE COMPOSITE MODEL FOR NEW UNSTABLE PARTICLES. I. S.Tanaka.
Progr. theor. Phys., Vol. 16, No. 6, 625-30 (Dec., 1956).

Models for K-mesons are discussed from the view-point of regarding new unstable particles as composite particles. To interpret the degeneracy of masses of K-mesons, the existence of two kinds of $\Lambda$-particles is assumed together with nucleon as fundamental particles, and several models for K-mesons are considered. A.

539.18

7412. THE COMPOSITE MODEL FOR NEW UNSTABLE PARTICLES. II. S.Tanaka.
Progr. theor. Phys., Vol. 16, No. 6, 631-40 (Dec., 1956).

The composite particles, which are composed of fundamental particles combined by strong Fermi-interactions, are assumed to disintegrate through the several universal weak Fermi-couplings. It is examined from the standpoint of the universal weak Fermi-couplings whether the conditions required for the internal wave-functions of composite $\pi$ and K mesons from experimental results, i.e., observed lifetimes or masses of new particles, are mutually consistent. A.

539.18 : 530.145

PREDICTIONS OF MESON MASSES AND DECAYS. See Abstr. 6875

539.18 : 537.591.1

COSMIC-RAY $\mu$-MESONS AT GREAT DEPTHS. See Abstr. 7195

539.18

7413. ANGULAR CORRELATION IN THE DECAY OF THE $\tau$-MESON. W.Lindt.
Arch. Sci. (Geneva), Vol. 9, No. 4, 457-61 (1956). In French.

The angular distribution functions for the decay of the $\tau$-meson have been developed in terms of spherical harmonics. It is shown that the Dalitz–Fabri expression is to be preferred for determining the spin of the $\tau$-meson. A.J.Egginton

539.18

7414. REPORT ON LONG-LIVED $K^0$-MESONS.
K.Lande, L.M.Lederman and W.Chinowsky.
Phys. Rev., Vol. 105, No. 4, 1925-7 (March 15, 1957).

Continuing a previous experiment (Abstr. 2683/1957) 5000 photographs taken in the $K^0$ beam at the Cosmotron are examined; the $K^0$ yield was one per 35 photographs. From the $p_t$ distribution of the charged and neutral secondaries from 100 decays it is concluded that the main decay processes are $\pi e\nu$ and $\pi\mu\nu$ and that there is convincing evidence for the $\pi^+\pi^+\pi^0$ mode. Ionization measurements to determine secondary masses are in progress. Further evidence favouring the particle-mixture theory is provided by a $K^0$ (probably $K^0_2$) absorption in He giving a $\Sigma^-$. K.H.Barker

539.18

7415. ENERGY DEPENDENCE OF THE ASYMMETRY IN THE BETA DECAY OF POLARIZED MUONS. D.Berley, T.Coffin, R.L.Garwin, L.M.Lederman and M.Weinrich.
Phys. Rev., Vol. 106, No. 4, 835-6 (May 15, 1957).

The asymmetry in the angular distribution of positrons from a polarized muon beam was measured as a function of positron energy. The results are in good agreement with the predictions of the two-component neutrino theory. Limits on the additional parameters appearing in the four-component neutrino theory are also given. J.W.G.Wignall

539.18

7416. NUCLEAR EMULSION EVIDENCE FOR PARITY NON-CONSERVATION IN THE DECAY CHAIN $\pi^+ \to \mu^+ \to e^+$.
J.I.Friedman and V.L.Telegdi.
Phys. Rev., Vol. 106, No. 6, 1290-3 (June 15, 1957).

Following a suggestion of Lee and Yang (Abstr. 5596/1957), the correlation between the initial direction of motion of the muon and the direction of emission of the positron in the decay chain $\pi^+ \to \mu^+ \to e^+$ was investigated in nuclear emulsion to detect a possible parity nonconservation in both decay interactions. Positive pions from the University of Chicago synchrocyclotron were brought to rest in emulsion carefully shielded from magnetic fields, and 2000 complete decay events were measured. A correlation $W(\theta) = 1 + a\cos\theta$ was found, with $a = -0.174 \pm 0.038$, clearly indicating a backward-forward symmetry, i.e., a violation of parity conservation in both decay processes. Actually, following an argument of Lee, Oehme and Yang, this asymmetry implies a noninvariance of either interaction with respect to both space inversion and charge conjugation, taken separately. A detailed discussion of a depolarization process specific to $\mu^+$ mesons, i.e., the possible formation of "muonium", $(\mu^+e^-)$, is given. The results of this and similar experiments are compared with those obtained with muons originating from $\pi^+$-decays in flight, and the implications of such a comparison are discussed. A.

539.18

7417. INFORMATION OBTAINABLE ON POLARIZATION OF $\mu^+$ AND ASYMMETRY OF $e^+$ IN MUONIUM EXPERIMENTS.
G.Breit and V.W.Hughes.
Phys. Rev., Vol. 106, No. 6, 1293-5 (June 15, 1957).

The formation of the compound $\mu^+ + e^-$ (muonium) is considered as a tool for gaining information regarding the polarization of the $\mu^+$ before their capture by the $e^-$ and the asymmetry of $e^+$ emission in the disintegration $\mu^+ \to e^+ + \nu + \nu'$. The detection of asymmetry effects is supposed to take place through the counting of $e^+$. The effect of constant magnetic fields and of microwave-induced transitions among magnetic substates of muonium is calculated, with the conclusion that all of the experiments considered here determine in different ways the same combination of parameters describing the initial muon polarization and the asymmetry of $e^+$ emission in muon decay. A.

539.18

7418. PARITY MIXING EFFECTS IN $\tau-\theta$ DECAY.
S.B.Treiman and H.W.Wyld,Jr.
Phys. Rev., Vol. 106, No. 6, 1320-3 (June 15, 1957).

The recent results on nonconservation of parity in decay processes involving neutrinos do not provide an unambiguous solution of the $\tau-\theta$ puzzle. In fact the $2\pi$ and $3\pi$ decay modes of $\theta$ and $\tau$ involve no neutrinos, whereas the Lee–Yang two-component neutrino theory attributes the nonconservation of parity to special properties of the neutrino. However, even if the $\tau$ and $\theta$ are different particles with opposite parities, the neutrino decay modes $(\mu,\nu)$, $(e,\pi,\nu)$, and $(\mu,\pi,\nu)$, which presumably violate parity conservation, will cause mixing of the two particles $\tau$ and $\theta$ – in the sense that the states with definite lifetimes will be certain linear combinations, $K_1$ and $K_2$, of $\tau$ and $\theta$. Both $K_1$ and $K_2$ will then decay into both $2\pi$ and $3\pi$ as well as the neutrino modes, but with different lifetimes. An explanation of the apparent equality of lifetimes of $\tau$ and $\theta$ may be that under present experimental conditions only the long-lived component $K_2$ is observed. If this is the case, interference effects between the $K_1$ and $K_2$ components should be found in experiments performed at shorter times. Conversely, absence of such effects would constitute strong evidence that $\tau$ and $\theta$ are identical. Phenomenological expressions are derived by the Wigner–Weisskopf method for the decay rates, including interference effects; and various experimental possibilities are discussed. A.

539.18

7419. NOTE ON THE DECAY INTERACTIONS OF HYPERONS AND HEAVY MESONS. C.Iso and M.Kawaguchi.
Progr. theor. Phys., Vol. 16, No. 3, 177-88 (Sept., 1956).

The decay processes are investigated based on Nishijima and Gell-Mann's charge independence theory of heavy unstable particles. It is assumed that the decay interaction Hamiltonian is a spinor in isotopic spin space, when all particles participating in a decay process have definite isotopic spins. The branching ratio of various decay modes including radiative decays and the relation of lifetimes among charge multiplets are obtained. For instance, the difference between lifetimes of $\theta^0$ and of $\theta^+$, and the branching ratio of the $\tau^+$-particle are well interpreted under this assumption. The theory developed here is also applied to the decay of the lightest hyperfragment $^3H_\Lambda$. A.

539.18

7420. NOTE ON THE DECAY OF $\Xi$ PARTICLES. S.Hatano.
Progr. theor. Phys., Vol. 16, No. 3, 248 - 50 (Sept., 1956).

Assuming that the $\Xi$-hyperon is a compound of $\Lambda$ and $\bar{K}$, its lifetime is calculated for decay via an intermediate state involving a $\tau^-$ meson. The result is about $10^{-3}$ of the $\tau^-$-lifetime. J.W.G.Wignall

539.18

7421. DISINTEGRATION OF HYPERFRAGMENTS. III.
J. Schneps, W.F.Fry and M.S.Swami.
Phys. Rev., Vol. 106, No. 5, 1062-71 (June 1, 1957).

For Pt II, see Abstr. 4659 (1956). The systematic study of hyperfragments using nuclear emulsion, which has been reported on in two previous papers, has been continued. Examples of $_\Lambda H^4$, $_\Lambda He$, and $_\Lambda Li$ hyperfragments are reported here. $\Lambda^0$-particle binding energies previously reported have been corrected according to the latest range–energy data of Barkas et al. Average values found for the binding energy $B_\Lambda$ are:

$_\Lambda H^3(B_\Lambda = -0.3 \pm 0.4$ MeV); $_\Lambda H^4(B_\Lambda = 1.8 \pm 0.4$ MeV);
$_\Lambda He^4(B_\Lambda = 1.9 \pm 0.4$ MeV); $_\Lambda He^5(B_\Lambda = 1.6 \pm 0.6$ MeV);
$_\Lambda Li^6(B_\Lambda = 6.8 \pm 3.0$ MeV); $_\Lambda Li^6$ or $_\Lambda Li^7(B_\Lambda = 5.2$ or $5.0 \pm 2.5$ MeV);
$_\Lambda Li^7$ or $_\Lambda Li^8(B_\Lambda = 5.1 \pm 0.6$ MeV); $_\Lambda Be^8(B_\Lambda = 5.1 \pm 4.0$ MeV);
$_\Lambda Be^9(B_\Lambda = 6.2 \pm 0.6$ MeV); $_\Lambda C^{11}(B_\Lambda = 13 \pm 6$ MeV).

The absence of $_\Lambda H^3$ indicates the $\Lambda^0$-nucleon system does not have a bound state. The absence of $_\Lambda He^3$ implies that $_\Lambda H^3$ is an isotopic spin singlet. The agreement in the binding energies of $_\Lambda H^4$ and $_\Lambda He^4$ supports the hypothesis of charge independence for $\Lambda^0$-nucleon forces. The ratios of nonmesonic to mesonic decays of hyperfragments $Q^{(-)}$, as defined by Ruderman and Karplus (Abstr. 4013/1956), are found to be: for hydrogen hyperfragments $Q^{(-)} = 0$; for helium $Q^{(-)} = 1.5$; for hyperfragments of $Z \geq 3$, $Q^{(-)} = 43$. According to the analysis of Ruderman and Karplus these values suggest that the $\Lambda^0$-particle decays into an angular momentum state of $l = 0$ or $l = 1$, and hence that the spin of the $\Lambda^0$ is either $\frac{1}{2}$ or $\frac{3}{2}$. In the case of hyperfragments which decay into a proton, $\pi^-$-meson, and a recoil, the angle $\theta_{A\pi}$ between the $\pi^-$-meson direction in the $\Lambda^0$ rest frame and the direction of motion of the $\Lambda^0$ within the hyperfragment can be measured,

if it is assumed that the interaction of the decay particles is negligible. The distribution of these angles shows a peaking in the forward and backward directions. This is suggestive of a spin greater than ½ for the $\Lambda^0$. A.

539.18

7422. DISINTEGRATION OF HYPERFRAGMENTS.
O.Skjeggestad, S.O.Sörensen and A.Solheim.
Phys. Rev., Vol. 106, No. 6, 1280-5 (June 15, 1957).

The decay of 10 hyperfragments of hydrogen, helium, and lithium is described. Only one event is uniquely identified, as $H^{4*} \rightarrow He^3 + n + \pi^-$; it gives a binding energy of the $\Lambda^0$ particle $B.E.(\Lambda^0) = 1.5 \pm 0.7$ MeV. One event represents the decay in flight of a hydrogen hyperfragment. In one case a helium hyperfragment was ejected from a star produced by a negative K-meson. A very simple method for charge determination of short fragments emitted in nuclear disintegrations is described and applied to the identification of hyperfragments. A.

539.18

7423. MAXIMUM LIKELIHOOD ESTIMATION OF $K^+$-MESON LIFETIME. D.F.Davis, T.F.Hoang and M.F.Kaplon.
Phys. Rev., Vol. 106, No. 5, 1049-50 (June 1, 1957).

The method of maximum likelihood is applied to the observations of the decay in flight of $K_L^+$ and $\tau^+$-mesons in emulsion. The values obtained are $(1.19 \pm 0.17) \times 10^{-8}$ sec and $(1.06 \pm 0.53) \times 10^{-8}$ sec, respectively. Possible sources of error in the application of this method to $K^+$-beams in emulsion are discussed. A.

539.18

7424. BURST PRODUCTION BY SPIN-3/2 PARTICLES.
A.N.Mitra.
Nuclear Physics, Vol. 2, No. 3, 283-5 (Nov., 1956).

Interpretation of burst data dependent on the fluctuation distribution assumed for an electron—photon shower. The spin of the $\mu$-meson cannot be unambiguously inferred from such data, since the correct distribution is uncertain, and could be as high as 3/2 if the number fluctuations are small. K.H.Barker

539.18

7425. ON THE SPIN AND PARITY OF THE $\tau$-MESON.
I.S.Shapiro, E.I.Dolinsky and A.P.Mishakova.
Nuclear Physics, Vol. 3, No. 1, 60-4 (March, 1957).

Energy distribution curves of $\pi^-$-mesons produced in $\tau^+$-decays have been obtained by assuming that the isobaric spin of the three $\pi$-meson system equals unity and the ratio of probabilities of $\tau$- and $\tau'$-decays is 4. Comparison of the theoretical results with experimental data referring to 492 $\tau^+$-decay events shows that the most probable values for $\tau$-meson spin and parity is the $0^-$ combination. A.

539.18

7426. EVIDENCE AGAINST SPIN 1 FOR THE $\tau$ MESON.
J.Orear.
Phys. Rev., Vol. 106, No. 4, 834-5 (May 15, 1957).

The momentum dependence of low-energy negative pions observed in $\tau$-decay is analysed by the least-squares and likelihood-ratio methods. The latter gives a probability of less than $10^{-4}$ that the spin of the $\tau$-meson is odd. J.W.G.Wignall

539.18

7427. ON THE DETERMINATION OF THE SPINS OF $\Lambda^0$ AND $\theta^0$ PARTICLES. S.Hori.
Progr. theor. Phys., Vol. 16, No. 3, 189-96 (Sept., 1956).

A complete angular correlation function is derived, which is concerned with the directions of decay secondaries from $\Lambda^0$- and $\theta^0$-particles produced in a $\pi^-$—p collision and of the incident $\pi^-$-meson. The function is evaluated for a simplified case in which it is assumed that the spin of $\theta^0$ is zero and the $\Lambda^0$—$\theta^0$ system is produced in S-state in centre-of-mass system. For the case of the spin of $\Lambda^0 = 3/2$, the result agrees with that reported by L.Wolfenstein (1954). A.

539.18

7428. APPLICATION OF DISPERSION RELATIONS TO LOW-ENERGY MESON—NUCLEON SCATTERING.
G.F.Chew, M.L.Goldberger, F.E.Low and Y.Nambu.
Phys. Rev., Vol. 106, No. 6, 1337-44 (June 15, 1957).

Relativistic dispersion relations are used to derive equations for low-energy S-, P-, and D-wave meson—nucleon scattering under the assumption that the (3,3) resonance dominates the dispersion integrals. The P-wave equations so obtained differ only slightly from those of the static fixed-source theory. The conclusions of the static theory are re-examined in the light of their new derivation. A.

539.18

7429. THE SCATTERING OF HIGH ENERGY $\mu$-MESONS IN LEAD.
J.L.Lloyd, E.Rössle and A.W.Wolfendale.
Proc. Phys. Soc. A, Vol. 70, Pt 6, 421-32 (June, 1957).

A study has been made of the scattering of $\mu$-mesons, in the momentum range 5-150 GeV/c, by a thick block of lead. The experimental scattering distribution shows an excess of large displacements over the number expected on conventional scattering theory, indicating that the anomalous scattering found at low energies extends to these high energies. A.

539.18

7430. SCATTERING OF $\pi$-MESONS BY NUCLEONS IN THE HIGHER APPROXIMATION OF THE TAMM—DANKOV [DANCOFF] METHOD. Yu.M.Popov.
Zh. éksper. teor. Fiz., Vol. 32, No. 1, 169-71 (1957). In Russian.

The general Tamm—Dancoff equation for the pion—nucleon interactions is set up and the discussion of Dalitz and Dyson (Abstr. 7702/1955) is extended to the elimination of explicit non-physical singularities in the higher-order approximation. However, the difficulties which prevented a numerical evaluation of the first-order interaction apply a fortiori, to the higher orders. J.W.Gardner

539.18

7431. THE CAPTURE OF STOPPED NEGATIVE PIONS BY HYDROGEN. J.M.Cassels, G.Fidecaro, A.M.Wetherell and J.R.Wormald.
Proc. Phys. Soc. A, Vol. 70, Pt 6, 405-14 (June, 1957).

A total absorption Cherenkov $\gamma$-ray spectrometer has been used to study the relative probabilities of mesonic and radiative capture. The ratio was found to be $1.50 \pm 0.15$. This result is collated with other data concerning the interaction of low-energy pions with nucleons and radiation. Reasonable consistency is found. A.

539.18

7432. ON THE INTERACTION OF NEGATIVE K-MESONS AT REST WITH TWO NUCLEONS.
A.Berthelot, O.Goussu, F.Lévy and L.Scarsi.
C.R. Acad. Sci. (Paris), Vol. 244, No. 4, 447-50 (Jan. 21, 1957). In French.

Two definite and two possible cases of $K^-$mesons interacting simultaneously with two nucleons to produce a nucleon and a charged hyperon are described. Five events in each of which a high energy proton was observed are interpreted as examples of the analogous process involving the production of a neutral hyperon. J.W.G.Wignall

539.18 : 537.591.5

7433. NUCLEAR INTERACTIONS OF $\mu$-MESONS UNDERGROUND. VARIATION OF THE FLUX OF PROTONS AND $\pi$-MESONS WITH DEPTH. L.Avan and M.Avan.
C.R. Acad. Sci. (Paris), Vol. 244, No. 5, 589-92 (Jan. 28, 1957). In French.

Nuclear emulsions were exposed underground at three different depths (−300, −500, and −1280 metres water equivalent). A cross-section for the formation of stars by $\mu$-mesons of $\sim 8.5$ $\mu$ barns/nucleon is deduced, and the ratios of the numbers of single protons and $\pi$-mesons to the numbers of $\mu$-mesons at the different depths is given. P.Rothwell

539.18

7434. INTERACTION AND DECAY OF $K^+$ MESONS IN FLIGHT.
C.Marchi, E.Pedretti and S.Stantic.
Nuovo Cimento (Ser. 10), Vol. 4, No. 4, 940-3 (Oct., 1956).

G-5 stripped emulsions 600$\mu$ thick were exposed to positive particles with momenta ~400 MeV/c from the Bevatron. In following (23 ± 0.43) m of K-meson track, 45 elastic, 15 inelastic and 6 charge-exchange scatterings are identified; among the scatterings without visible excitation 9 are classified as inelastic from grain-density measurements. The mean free path for incoherent interactions of K-mesons in the energy range 20-130 MeV is $(0.93 \pm 0.19)$ m after making a geometrical correction. Whereas the mean free path is roughly energy-independent for the inelastic events the charge-exchanges are found in the high-energy region. The mean life of the K-mesons is determined as $(1.13 \pm 0.31) \times 10^{-8}$ sec. K.H.Barker

539.18

7435. ON $\mu$-DISINTEGRATIONS OF K-MESONS AND HYPERONS.
L.B.Okun'.
Zh. éksper. teor. Fiz., Vol. 32, No. 2, 400-2 (1957). In Russian.

Schwinger has suggested that weak interactions of $\mu$-mesons and neutrinos with $\pi$ and K-mesons are primary, and the interactions

of $\mu$-mesons with hyperons and nucleons are secondary and derive from this weak boson–fermion interaction. It is argued that the consequences of this hypothesis can be derived from other hypotheses also. The work of Sachs (Abstr. 9940/1955) and Sachs and Treiman (Abstr. 742/1957) is quoted as an example. S.Chomet

539.18 : 539.152

MESOATOMS. See Abstr. 7282

539.18 : 539.172.3

7436. PHOTOPRODUCTION OF $\pi^0$-MESONS ON COMPLEX NUCLEI. A.S.Belousov, E.I.Tamm and E.V.Shitov.
Dokl. Akad. Nauk SSSR, Vol 112, No. 6, 1017-19 (1957). In Russian.

Targets of Li, C, Al, Cu, Cd and Pb were irradiated with $\gamma$-rays ($E_\gamma^{max}$ = 265 MeV and $E_\gamma^{max}$ = 200 MeV). $\gamma$-rays from the disintegrations of $\pi^0$-mesons produced in these targets were recorded by a scintillation counter telescope at 90° to the direction of the primary $\gamma$-ray beam. Taking into account the work of Panofsky et al. (Abstr. 5328/1952) it is concluded that the character of the dependence of the cross-section for the production of $\pi^0$-mesons on nuclei, on the atomic number is the same for $E_\gamma^{max}$ = 310, 265 and 200 MeV. S.Chomet

539.18

7437. MONTE CARLO CALCULATION OF SINGLE PION PRODUCTION BY PIONS. J.E.Crew, R.D.Hill and L.S.Lavatelli.
Phys. Rev., Vol. 106, No. 5, 1051-6 (June 1, 1957).

A phenomenological calculation of single pion production in a pion–nucleon collision has been made using a $\frac{3}{2},\frac{3}{2}$ isobaric nucleon model and a Monte Carlo type of calculation on a high-speed digital computer. The results are in good agreement with observations of pion production for incident pion energies of approximately 1.0 and 1.5 BeV. A.

539.18

7438. RELATIVISTIC DISPERSION RELATION APPROACH TO PHOTOMESON PRODUCTION.
G.F.Chew, M.L.Goldberger, F.E.Low and Y.Nambu.
Phys. Rev., Vol. 106, No. 6, 1345-55 (June 15, 1957).

Relativistic dispersion relations for photomeson production, analogous to the pion–nucleon scattering dispersion relations, are formulated without proof. The assumption that the (3,3) resonance dominates the dispersion integrals then leads to detailed predictions about the photomeson amplitude. An attempt is made to keep first order (in v/c) nucleon recoil effects. Except for the latter, the predictions of the cutoff model are generally reproduced. A.

539.18 : 539.172.13

MESON PRODUCTION IN PROTON-DEUTERIUM REACTIONS. See Abstr. 7372

539.185

7439. TEST OF NEUTRINO–ANTINEUTRINO IDENTITY.
C.L.Cowan, Jr and F.Reines.
Phys. Rev., Vol. 106, No. 4, 825 (May 15, 1957).

New mass spectroscopic data for the atomic masses of $Nd^{150}$ and $Sm^{150}$, in conjunction with a double $\beta$-decay search using $Nd^{150}$, confirm the conclusion that the Majorana hypothesis that the neutrino is identical with the antineutrino is inapplicable. L.Pincherle

539.185

7440. INELASTIC SCATTERING OF NEUTRONS BY PARAMAGNETIC MEDIA. P.G.de Gennes.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 752-5 (Feb. 4, 1957). In French.

The energy spectrum of neutrons scattered by a paramagnetic substance is calculated for high temperatures, assuming exchange forces. The results represent a modification of those given by Van Vleck (1939). J.Thewlis

539.185

7441. SCATTERING OF NEUTRONS BY SPIN WAVES IN MAGNETITE. B.N.Brockhouse.
Phys. Rev., Vol. 106, No. 5, 859-64 (June 1, 1957).

Measurements of energy distributions of 1.5 A neutrons diffusely scattered by a single crystal of magnetite in the region of the 111 reciprocal-lattice point were carried out. Neutron groups were observed which satisfy momentum and energy conservation between the neutron and one wave-excitation quantum, and which are assigned a magnetic origin. The intensities of the neutron groups are consistent with spin wave theory within the limits of the analysis. The measurements are not sufficiently exact to enable the form of the frequency/wave-number relation of the spin waves to be deduced but assuming the quadratic relation of Kaplan a value for the A–B exchange integral of $2 \times 10^{-3}$ eV is obtained. A.

539.185 : 537.534.74

ELASTIC NEUTRON-PROTON SCATTERING AT 380 MeV. See Abstr. 7171

539.185 : 537.534.74

NEUTRON–PROTON SCATTERING. See Abstr. 7172

539.185.08

7442. ABSOLUTE DETERMINATION OF THE NUMBER OF NEUTRONS EMITTED PER UNIT TIME BY A STANDARD Ra$\alpha$Be SOURCE. M.Gailloud.
Ann. Phys. (Paris), Ser. 13, Vol. 1, 808-53 (Sept.-Oct., 1956). In French.

The method combines the techniques of geometric integration near the source where the neutron intensity is high with physical integration at a distance from the source by measuring (using photographic emulsions impregnated with B) the number of neutrons absorbed in a sphere containing B in solution, and the activity produced by the source in a solution containing Mn, first with and then without the sphere of B-containing solution around it. Sources of errors are discussed and results are given for several standard sources and compared with those obtained elsewhere. A.O.Stanesby

539.185.08 : 537.542 : 621.374.32

1000-CHANNEL NEUTRON-VELOCITY SPECTROMETER USING FERRITE DATA STORAGE. See Abstr. 7180

# STRUCTURE OF SOLIDS 539.2

539.21 : 548.7

7443. THE EFFECT OF RADIATION DAMAGE ON THE ELECTRONIC PROPERTIES OF SOLIDS. E.W.J.Mitchell.
Brit. J. appl. Phys., Vol. 8, No. 5, 179-89 (May, 1957).

An outline is given of the way in which the concentration of defects introduced by irradiation may be estimated. The topics which are discussed are the effects of irradiation on the electron mobility in metals, the carrier concentration in germanium and the optical absorption in quartz and diamond. The emphasis in the discussion of results is on their contribution to the study of defects in solids. A.

539.215

7444. THE PENETRATION OF IRREGULARLY-SHAPED PARTICLES THROUGH AN AIRBORNE-DUST ELUTRIATOR.
J.G.Dawes, G.K.Greenough and J.S.Seager.
Brit. J. appl. Phys., Vol. 8, No. 6, 236-41 (June, 1957).

A connection is established between the shape-factor distribution relating the projected-area diameters ($D_M$) and the Stokes' diameters ($D_S$) of particles in a dust cloud, and the penetration efficiency $E(D_M)$ of a standard elutriator for those particles determined by the microscope evaluation of thermal precipitator samples taken with and without the elutriator. From the measured characteristic $E(D_M)$ in a given dust cloud, it is possible to estimate the mean value of the shape factor $D_S/D_M$ of the cloud, and its coefficient of variation. A.

539.215.08

7445. A PHOTOELECTRIC PARTICLE COUNTER FOR USE IN THE SIEVE RANGE. T.Beirne and J.M.Hutcheon.
J. sci. Instrum., Vol. 34, No. 5, 196-200 (May, 1957).

A photoelectric particle counter has been designed for the rapid measurement of the number of particles per gram in sieved fractions of opaque powders. The instrument can also be used for the determination of the size distribution of a powder in the sieve range in terms of numbers of particles. A.

539.216

7446. SOME APPLICATIONS OF PHYSICS TO WOOD.
R.F.S.Hearmon.
Brit. J. appl. Phys., Vol. 8, No. 2, 49-58 (Feb., 1957).

A review is given of some of the more important physical properties of wood, particularly the hygroscopic, thermal, electrical and elastic properties. The vibration behaviour is also considered, with special reference to the effect of shear and rotatory inertia in flexural vibration, and to the connection between frequency of vibration and elastic stability. A.

539.217

7447. DIFFUSION OF RADIOACTIVE IONS IN CRYSTALS (WITH APPLICATIONS). M.Chemla.
Ann. Phys. (Paris), Ser. 13, Vol. 1, 959-1002 (Nov.-Dec., 1956). In French.

A thesis in two parts; (I) general, (II) with special attention

to diffusion in NaCl single crystals. Pt I briefly covers the fundamental laws of diffusion, the experimental methods of measuring diffusion coefficients (D), possible atomic mechanisms of diffusion and the calculation of diffusion coefficients for these mechanisms. Pt II begins with the diffusion of $S^{35}$ and $P^{32}$ in NaCl: an initially uniform distribution of these elements is produced by fast neutron irradiation [Cl(n,p) and Cl(n,$\alpha$) reactions] but on annealing at high temperatures they migrate to the surface and from their distributions in the crystal at any stage $D(S^{35})$ and $D(P^{32})$ are determined. Results in the range 500°C to 700°C show that for both elements D is greater than the $Na^+$ self-diffusion coefficient. The experiments were repeated in an electric field to obtain the electrical mobility, $\mu$, also: the ratio $\mu/D$ was found considerably smaller than e/kT. Diffusion, also in NaCl, of the monovalent cations $(K^{42})^+$, $(Rb^{86})^+$, $(Cs^{137})^+$, $(Ag^{110})^+$ was studied by conventional technique (in the range ~600°C to ~750°C) giving D-values increasing in that order. In addition the $(Cs^{137})^+$ experiment was repeated in an electric field, the ratio $\mu/D$ being closely equal to the Einstein value e/kT. The behaviour of the monovalent anions $(Cl^{36})^-$, $(Br^{82})^-$, $(I^{131})^-$ was also studied (600°C to 750°C) and again the Einstein relation was satisfied. On the other hand the multivalent cations $(Zn^{65})^{2+}$, $(Sr^{90})^{2+}$, $(Fe^{55})^{3+}$, $(Y^{90})^{3+}$, like the anionic S and P, diffused rapidly and showed violation of the Einstein relation. The technique of diffusion in an electric field was used to enhance the enrichment of the ratio $Na^{22}$ to $Na^{24}$ in a mixture diffusing into NaCl and KCl consequent upon their different D-values ($D\sqrt{M}$ = constant, M = mass of ion). The results on $S^{35}$ and $P^{32}$ are applied to the preparation of these isotopes in the pure state. A.B.Lidiard

539.217 : 548.7

7448. VACANCY DIFFUSION MECHANISM IN ORDERED ALLOYS. A.B.Lidiard.
Phys. Rev., Vol. 106, No. 4, 823 (May 15, 1957).

A theoretical discussion of the ratio, $D_B/D_A$, of the self-diffusion coefficients of the components of a binary alloy AB is given, assuming a mechanism in which lattice vacancies make nearest-neighbour jumps. The formula given by Slifkin and Tomizuka (Abstr. 4799/1957) for the dependence of $D_B/D_A$ on long-range order s is shown to be inconsistent with the condition that the alloy be in thermodynamic equilibrium, and the view that $D_B/D_A \to 1$ as $s \to 1$ is contested. A.B.Lidiard

539.217

7449. SELF-DIFFUSION IN GOLD.
S.M.Makin, A.H.Rowe and A.D.LeClaire.
Proc. Phys. Soc. B, Vol. 70, Pt 6, 545-52 (June, 1957).

The self-diffusion coefficient D of 99.95% purity gold has been measured in the temperature range 704°C to 1048°C using the sectioning method. D was found to vary with temperature according to the equation

$$D = (0.091 \pm 0.001) \exp[-(41\,700 \pm 300)/RT] \text{ cm}^2 \text{ sec}^{-1}.$$

A detailed comparison of this result is made with those of earlier workers. A.

539.217 : 538.221

INVESTIGATION OF THE DIFFUSION OF CARBON IN IRON.
See Abstr. 7214

539.217.1

7450. STUDY OF THE POROSITY OF SOLIDS. II. REMARKS ON THE METHOD OF CALCULATION OF THE DISTRIBUTION OF THE PORES AND ON THE FORM OF THE ISOTHERMS.
B.Imelik and J.François-Rossetti.
Bull. Soc. Chim. France, No. 2, 153-8 (Feb., 1957). In French.

See Abstr. 3904 (1954). Various methods for calculating the pore-size distribution are discussed, more particularly in relation to the pressure at which multilayer formation commences. Type IV isotherms tend to yield more accurate results than type II. S.J.Gregg

539.23

7451. SUMMARIZED PROCEEDINGS OF A SYMPOSIUM ON THIN FILMS, READING, SEPTEMBER, 1956. T.B.Rymer.
Brit. J. appl. Phys., Vol. 8, No. 3, 97-100 (March, 1957).

The electronics Group of The Institute of Physics held an informal symposium on thin films at the University of Reading on 28 and 29 September, 1956. The papers presented are summarized in the report. A.

539.234

7452. VACUUM-DEPOSITED FILMS OF NICKEL–CHROMIUM ALLOY. R.H.Alderson and F.Ashworth.
Brit. J. appl. Phys., Vol. 8, No. 5, 205-10 (May, 1957).

The preparation and properties of stable films of vacuum-deposited nickel–chromium alloy are described. Properties discussed include the film-alloy composition, the relationship between film thickness and resistance ($\Omega$/square), the temperature coefficient of resistance, grain size in the film (electron micrographs), mechanical failure of stressed films, optical transmission as a function of film thickness, fundamental noise and electrical breakdown under low- and high-frequency conditions. Graphs summarize the data and micrographs illustrate grain growth, breakdown due to stresses in the film and electrical breakdown in microwave attenuators. A.

539.26

7453. FLUOROSCOPY WITH AN ENLARGED IMAGE.
R.Halmshaw and C.Hunt.
Brit. J. appl. Phys., Vol. 8, No. 7, 282-8 (July, 1957).

Comparisons of attainable sensitivity have been made between two types of fluoroscopic set, one having an ultra-fine focus tube used with projective magnification and the other a conventional high current tube used with the specimen close to the screen. A marked gain in sensitivity was obtained with the former, values better than $1\frac{1}{2}$% being obtained over a range of thickness of aluminium, and better than 3% on steel, using wire penetrameters. Sensitivities have been calculated, in terms of the performance of the eye at different brightnesses and possible methods of improving sensitivity are considered. A.

539.27 : 537.533.35

7454. SOME CARBON REPLICA TECHNIQUES FOR THE ELECTRON MICROSCOPY OF SMALL SPECIMENS AND FIBRES.
D.E.Bradley.
Brit. J. appl. Phys., Vol. 8, No. 4, 150-4 (April, 1957).

The difficulties encountered in making replicas of fibres and other small specimens are discussed, and three carbon replica methods are described. The first is designed specifically for fibres. The tedious partial embedding techniques which have hitherto been required for such specimens are eliminated. The second method is for small specimens which are difficult to handle and range between about 0.5 and 2.0 mm in size. It has not been possible to use conventional methods with these specimens. The third method is for soft biological specimens such as bacteria. Existing single-stage replica techniques failed with such specimens, largely because of the strong chemical reagents required to dissolve the organic materials. All three methods are illustrated by various applications. A.

539.27 : 548.74 : 548.73

7455. ELECTRON MICROSCOPE AND DIFFRACTION STUDIES OF 7% CHROMIUM–MOLYBDENUM STEELS. B.E.Williams.
Brit. J. appl. Phys., Vol. 8, No. 6, 241-7 (June, 1957).

An investigation into the structural properties of some 7% chromium-molybdenum creep resisting steels has been carried out using electron microscopy and diffraction. The presence of fine precipitate of titanium carbide in good creep steels is observed. A.

539.27 : 548.74

7456. SUMMARIZED PROCEEDINGS OF A CONFERENCE ON ELECTRON MICROSCOPY — READING, JULY, 1956.
C.E.Challice.
Brit. J. appl. Phys., Vol. 8, No. 7, 259-69 (July, 1957).

The annual conference of the Electron Microscopy Group of the Institute of Physics was held at the University of Reading on July 24-26, 1956. Papers covering the theory, construction, and application of the instrument were read, and in addition five papers on the applications of electron diffraction were presented. A.

539.27

7457. THE PREPARATION OF ELECTRON MICROSCOPE REPLICAS FROM ROUGH POROUS SURFACES. D.M.Hall.
Brit. J. appl. Phys., Vol. 8, No. 7, 295-6 (July, 1957).

A two-step collodion–carbon replica process is described for obtaining replicas from rough porous surfaces such as fractured teeth. Specimens are soaked in water and allowed to dry slowly so that a water block immediately below the surface prevents the collodion penetrating too deeply into the pores and ensures that the replicas can be stripped. The use of an amyl acetate/water interface to float the carbon replica while the primary collodion replica is being dissolved results in less damage to the carbon film than other methods used. A.

539.27

7458. ELECTRON MICROSCOPE EXAMINATION AND IDENTIFICATION OF INTERGRANULAR PRECIPITATES BY MICROFRACTOGRAPHY. G.Henry and J.Plateau.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1473-5 (March 11, 1957). In French.

The examination in the electron microscope of the surfaces after intergranular rupture provides a means for examining intergranular precipitates. A carbon replica technique is used which also enables the intergranular precipitates to be extracted.

A.E.I.Research Laboratory

539.27 : 548.74

ELECTRON-IMAGE RECORDING BY XEROGRAPHY. See Abstr. 6756

# ELASTICITY. STRENGTH. RHEOLOGY

## 539.3/.8

539.31

7459. THE DERIVATION OF THE MINIMAL PRINCIPLES OF NON-LINEAR ELASTICITY THEORY BY MEANS OF A CANONICAL TRANSFORMATION. E.Koppe.
Nachr. Akad. Wiss. Göttingen, Math.-Phys. Kl. IIa, No. 12, 259-66 (1956). In German.

Three general variational principles are obtained from the principle of virtual work, apparently valid without any restriction on the form of the relations between stresses and gradients of displacement. The mathematical form of the final result in each case is such that, for equilibrium, the sum of certain volume and surface integrals over the volume and surface of the undeformed body is stationary. J.G.Oldroyd

539.319 : 538.221

STRESS IN EVAPORATED FERROMAGNETIC FILMS. See Abstr. 7219

539.319 : 548.73

7460. THE MEASUREMENT OF SURFACE RESIDUAL STRESS BY X-RAYS. G.A.Hawkes.
Brit. J. appl. Phys., Vol. 8, No. 6, 229-32 (June, 1957).

A multi-exposure, X-ray, back-reflection technique, with graphical solution for the evaluation of the level of residual macro-stress in any particular surface direction in a polycrystalline material, is described. This technique has, in particular, been applied to the stress analysis of aluminium alloys and high tensile steel components and specimens. A.

539.32

7461. ON THE TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS OF A CUBIC LATTICE. G.K.Horton.
Z. Phys., Vol. 148, No. 2, 236-41 (1957). In German.

An equation involving the temperature variations of the elastic constants of cubic metals is implicitly contained in the Bhatia model for cubic metals. This result is of interest because it is closely connected with the question of the equilibrium condition in lattice dynamics. Recent experimental results on the elastic constants and thermal expansion coefficients of copper and aluminium are compared with a formula derived from the Bhatia theory. The experimental results are not yet sufficiently accurate to permit a detailed comparison with the theory though rough agreement is found. A.

539.32 : 548.7

INTERNAL FRICTION AND DEFECT INTERACTION IN GERMANIUM. See Abstr. 6718-19

539.32.08

7462. A METHOD OF MEASURING THE SHEAR MODULUS OF THIN XYLONITE SHEET. J.Clarkson.
Brit. J. appl. Phys., Vol. 8, No. 3, 103-4 (March, 1957).

A torsion balance is described, in which a common torque is applied to narrow strips of steel and xylonite connected end to end, and the twist of each specimen is measured. Knowing the shear modulus of steel, its twist gives a measure of the torque, and the shear modulus of the xylonite may then be calculated from its rotation. The measurements throughout are very easily made, and they do not depend in any way on frictional forces, nor are any forces applied to the specimens apart from the end forces producing the torque. These features are particularly important for thin xylonite which has very small torsional and bending stiffness. A.

539.32.08

7463. SOME CONSIDERATIONS OF THE MAGNETOSTRICTIVE COMPOSITE OSCILLATOR METHOD FOR THE MEASUREMENT OF ELASTIC MODULI. N.B.Terry.
Brit. J. appl. Phys., Vol. 8, No. 7, 270-5 (July, 1957).

The development of the composite oscillator method, using nickel transducers, to enable measurement of the rigidity moduli as well as the Young's moduli of small cylindrical specimens is described. The magnitude of the cementing errors for the different modes of excitation is examined both theoretically and experimentally. An analysis is given which shows the advantages, for the technique described, of resonating at the fundamental mode for specimens of relatively low characteristic acoustic impedance. A further consideration of errors due to cross-sectional mismatch between transducer and specimen is made and finally some measurements on coal specimens are given. A.

539.32.08

7464. ELASTIC CONSTANTS OF LiF FROM 4.2°K TO 300°K BY ULTRASONIC METHODS. C.V.Briscoe and C.F.Squire.
Phys. Rev., Vol. 106, No. 6, 1175-7 (June 15, 1957).

The values of the elastic constants of LiF at 4.2°K are found to be $c_{11} = 12.46 \times 10^{11}$, $c_{44} = 6.49 \times 10^{11}$, and $c_{12} = 4.24 \times 10^{11}$ dynes/cm$^2$. At 300°K $c_{11} = 11.12 \times 10^{11}$, $c_{44} = 6.28 \times 10^{11}$, and $c_{12} = 4.20 \times 10^{11}$ dynes/cm$^2$. A Debye characteristic temperature, $\theta_D$, has been calculated from these values by using the Houston method of averaging the velocity over different directions in the crystal. At 4.2°K, $\theta_D = 734$°K in good agreement with the specific heat work of Martin. At 300°K, $\theta_D = 708$°K which is not in good agreement with values derived from specific heat measurements. A model has been suggested in which a combination of Debye and Einstein terms is used in the specific heat theory. A.

539.371

7465. DYNAMIC SHEAR PROPERTIES OF SOME RUBBER-LIKE MATERIALS. W.P.Fletcher and A.N.Gent.
Brit. J. appl. Phys., Vol. 8, No. 5, 194-201 (May, 1957).

Measurements are described of the dynamic shear properties of a number of representative rubber-like materials, both vulcanized and unvulcanized, over a wide range of frequencies and temperatures. The major part of the transition from a rubber-like to a glass-like state has been investigated. Reduced values for the real component of the complex shear modulus and the ratio of the imaginary to the real part are presented, enabling the behaviour of the materials studied to be evaluated for other frequency and temperature conditions. A.

539.371 : 536.7

THERMODYNAMICS FOR ELASTIC SOLIDS. See Abstr. 7075

539.374

7466. THE EFFECT OF THIN FILMS OF GOLD ON THE MECHANICAL PROPERTIES OF CADMIUM SINGLE CRYSTALS. F.R.Lipsett and R.King.
Proc. Phys. Soc. B, Vol. 70, Pt 6, 608-20 (June, 1957).

Thin films of oxides, hydroxides or metals have been shown to increase the stress at which plastic deformation starts by an amount which cannot be explained by the strength of the films themselves. Most experiments have been on creep, showing the effect of oxides and hydroxides. This paper records an investigation into the effect of thin films of gold on the stress–strain curves of cadmium crystals. The crystals were grown in an Andrade–Roscoe furnace and extended in a rigid frame machine with a Polanyi beam and photographic recording. The gold films were deposited by sputtering. It was found that thin gold films increased the stress at which plastic deformation started by about 6 g wt mm$^{-2}$. The increase was independent of film thickness for films of 1500-24 000 A. The nature of the effect of the film upon the stress–strain curves depended upon the orientation of the crystals. A.

539.377 : 536.413

7467. SOME PECULIARITIES OF THERMAL DEFORMATION IN CRYSTALS. A.V.Shubnikov.
Kristallografiya, Vol. 1, No. 1, 95-104 (1956). In Russian.

An accurate method is given for obtaining the thermal deformation surface of crystals. The formula for the thermal expansion coefficient as a function of orientation is used to illustrate all the possible solid polar diagrams. In order to represent the thermal deformation surface completely, the thermal shear coefficient must be taken into account. R.F.S.Hearmon

539.537 : 548.

INDUCTION OF RING CRACKS ON DIAMOND SURFACES. See Abstr. 6686

539.839

7468. MISCELLANEOUS EFFECTS OF PRESSURE ON MISCELLANEOUS SUBSTANCES. P.W.Bridgman.
Proc. Amer. Acad. Arts Sci., Vol. 84, No. 1, 112-29 (1956).

The following data are given: (1) electrical resistance of Y, Re, Tc up to $10^5$ kg/cm$^2$ at room temperature and of Sr up to 200°C for $7 \times 10^3$ kg/cm$^2$; (2) volume compression of Y, Re, Pb, fluorothene, hen's egg yolk and white; (3) shearing strengths of Y, Tc and tensile properties of Cr, Ge; (4) resistance changes during plastic extension under pressure for Cu, Fe. F.Ansbacher

539.893 : 548.736.1

STRUCTURE OF BISMUTH AT PRESSURES UP TO 30 000 ATMOSPHERES. See Abstr. 6742

# PHYSICAL CHEMISTRY 541

## PHASE EQUILIBRIUM. CHEMICAL REACTIONS 541.11/.12

541.124

7469. CARBON ISOTOPE EFFECT DURING OXIDATION OF CARBON MONOXIDE WITH NITROGEN DIOXIDE.
H.S.Johnston, W.A.Bonner and D.J.Wilson.
J. chem. Phys., Vol. 26, No. 5, 1002-6 (May, 1957).

By use of naturally occurring $C^{12}$ and $C^{13}$ isotopes in carbon monoxide, the effect of carbon mass on the rate of the reaction $CO + NO_2 = CO_2 + NO$ has been studied in a 15 l. flask, in the temperature range 540-727°K, and at pressures between 1 and 20 mm. The rate constant for the reaction was $k = 12 \times 10^{12} \exp(-31\,600/RT)$ cm$^3$ mole$^{-1}$sec$^{-1}$. The ratio of rate constants $k_{12}/k_{13}$ was 1.022 at 540°K, 1.019 at 638°K, and 1.016 at 727°K. An activated complex was set up with normal bond distances and normal force constants, and with the reaction coordinate explicitly give in terms of internal coordinates with an interaction term such that the restoring force on an antisymmetric stretching symmetry coordinate is reduced to zero. By means of E.B.Wilson's FG matrix methods, a vibrational analysis was made of the activated complex, all vibration frequencies were determined for one species, and shifts in frequency due to isotopic substitution were computed by a perturbation method. Similarly, the ratio of effective mass of the reaction coordinate was evaluated, and calculations were checked by the Teller–Redlich product rule. The isotope rate effect was computed by Bigeleisen's formulation of the activated complex theory. For a set of force constants well within the range of normal values and for normal bond radii, calculated isotope rate ratios at all temperatures are in excellent agreement with observed ones. A.

541.127

7470. STUDIES IN NONEQUILIBRIUM RATE PROCESSES. I. THE RELAXATION OF A SYSTEM OF HARMONIC OSCILLATORS.
E.W.Montroll and K.E.Shuler.
J. chem. Phys., Vol. 26, No. 3, 454-64 (March, 1957).

As a part of an investigation of nonequilibrium phenomena in chemical kinetics a theoretical study has been made of the collisional and radiative relaxation of a system of harmonic oscillators contained in a constant temperature heat bath and prepared initially in a vibrational nonequilibrium distribution. An exact solution has been obtained for the general relaxation equation applicable to this system and expressions have been derived for the relaxation of initial Boltzmann distributions. Poisson distributions, and δ-function distributions as well as for the relaxation of the moments of the distributions. Using the latter result, explicit expressions are given for the relaxation of the internal energy of the system of oscillators and for the time dependence of the dispersion of the distributions. A.

541.127

7471. RATE CONSTANTS OF SECOND ORDER REACTIONS FROM KINETIC CURRENT MEASUREMENTS.
W.L.Reynolds and S.Prager.
J. chem. Phys., Vol. 26, No. 5, 1006-9 (May, 1957).

Kinetic currents have been calculated for the case where the solution contains two electroactive species, one of which may undergo a second order reaction with the reduced form of the other. The results have been applied to the reaction between ferrous versenate and cumene hydroperoxide, assuming the diffusion coefficients of all species to be equal. The calculated and observed rate constants are found to differ by 33%, which constitutes reasonable agreement in view of the assumptions made. A.

541.127

7472. RATE CONSTANTS AT LOW CONCENTRATIONS. I. RATE OF REACTION OF OZONE WITH NITROGEN DIOXIDE.
H.W.Ford, G.J.Doyle and N.Endow.
J. chem. Phys., Vol. 26, No. 5, 1336 (May, 1957).

The rate constant of the dark reaction of ozone with nitrogen dioxide at reactant concentrations less than one part per million of pure dry air and based on the mechanism

$$O_3 + NO_2 \xrightarrow{k_1} NO_3 + O_2 \text{ (rate determining step)}$$

$$NO_3 + NO_2 \xrightarrow{k_2} N_2O_5$$

was obtained from measurements in a 50-litre stirred flow reactor. $k_1 = 1.96 \times 10^4$ litre mole$^{-1}$ sec$^{-1}$. W.Good

541.127 : 541.14

7473. RATE CONSTANTS AT LOW CONCENTRATIONS. II. REACTION BETWEEN NITRIC OXIDE AND OZONE IN AIR AT ROOM TEMPERATURE. H.W.Ford, G.J.Doyle and N.Endow.
J. chem. Phys., Vol. 26, No. 5, 1337 (May, 1957).

For Pt I, see preceding abstract. $NO_2$ in the presence and absence of ozone, was photolysed at concentrations below one part per million parts by volume of pure dry air at atmospheric pressure and 29 ± 3°C. The light intensity was $1.0 \times 10^{16}$ quanta. cm$^{-2}$ sec$^{-1}$ at 3660 A. The steady state ozone level was calculated assuming the mechanism

$$NO_2 + h\nu \rightarrow NO + O$$
$$O + O_2 + M \rightarrow O_3 + M \text{ (fast)}$$
$$O_3 + NO \rightarrow NO_2 + O_2$$

The rate constant of the last step was found to be $3 \times 10^7$ litre mole$^{-1}$ sec$^{-1}$. W.Good

## ELECTROCHEMISTRY 541.13

541.133

7474. ELECTRICAL CONDUCTIVITY IN ELECTROLYTES AT HIGH FIELD STRENGTHS. LIMITING EFFECT. HIGHER CONCENTRATIONS. W.Fucks and K.Tesch.
Z. Phys., Vol. 148, No. 1, 53-60 (1957). In German.

The dependence on field strength of the conductance of aqueous solutions of $MgSO_4$ was measured using rectangular pulses of high voltage and a high voltage cathode-ray-oscillograph. At low concentrations the limiting effect was observed. Wilson's theory accounts for the Wien effect only up to 30 kV/cm; thereafter large deviations occur between theory and experiment. The theoretical calculations of Falkenhagen and Kelbg are in agreement with the present measurements, those of Wirtz in relation to the limiting effect are not confirmed. W.Good

## PHOTOCHEMISTRY. RADIATION CHEMISTRY 541.14/.15

541.14.

7475. RATE OF RECOMBINATION OF RADICALS. III. RATE OF RECOMBINATION OF ETHYL RADICALS.
A.Shepp and K.O.Kutschke.
J. chem. Phys., Vol. 26, No. 5, 1020-8 (May, 1957).

For Pt II see Abstr. 5478 (1956). The rate constants for the

recombination ($k_2$) and the disproportionation ($k_3$) of ethyl radicals have been determined by applying the theory of the rotating sector to the photolysis of diethyl ketone. The values of $k_2$ are $1.5 \pm 1 \times 10^{13}$, $2.0 \pm 0.5 \times 10^{13}$, and $4.2 \pm 0.8 \times 10^{13}$ $cm^3$ $mole^{-1}$ $sec^{-1}$, at 50°C, 100°C, and 150°C, respectively. The ratio $k_3/k_2$ is taken to be 0.12 from other work. An Arrhenius plot of these results indicates an energy of activation for $k_2$ of 2.0 ± 1 kcal/mole. These results are shown to be in agreement with existing theories. A simplified transition state theory calculation of $k_2$ is offered, based on the change in the number of degrees of freedom from radicals to activated complex. A.

541.144.8

7476. THE PHOTODISSOCIATION OF NITROGEN. I.I.Gromova.
Optika i Spektrosk., Vol. 1, No. 3, 433-4 (1956). In Russian.

The author calculates the potential curves of the nitrogen molecule for levels $X^1\Sigma_g^+$, $a^1\pi_g$, $A^3\Sigma_u^+$, $B^3\pi_g$ and $C^3\pi_u$ and compares with the observations of other workers. It is considered highly probable that nitrogen molecules at the $a^1\pi_g$ level will dissociate according to the $A^3\Sigma_u^+$ curve into two normal atoms of nitrogen in the $^4S$ state. C.R.S.Manders

541.15

7477. STUDY OF THE CHEMICAL TRANSFORMATIONS ACCOMPANYING NUCLEAR REACTIONS, WITH SPECIAL REFERENCE TO THE NUCLEAR REACTION $N^{14}(n,p)C^{14}$.
R.Muxart.
Bull. Soc. Chim. France, 1956, No. 11-12, 1857-61 (Nov.-Dec.). In French.

Reviews published information on the subject, noting especially the need to distinguish purely chemical effects from physico-chemical effects such as adsorption. J.M.Cassels

541.15

7478. RADIOLYSIS OF MIXTURES: CYCLOHEXANE–BENZENE–IODINE. M.Burton, J.Chang, S.Lipsky and M.P.Reddy.
J. chem. Phys., Vol. 26, No. 5, 1337-8 (May, 1957).

The variation with benzene concentration of the $H_2$ yield from the mixture when the latter is irradiated with $Co^{60}$ gamma-rays is studied. The yield is found to go through a maximum value with increasing benzene concentration. A mechanism is suggested to explain this result. W.Good

541.15 : 534.321.9

7479. THE ULTRASONIC DEGRADATION OF POLYSTYRENE AT A FREQUENCY OF 1 Mc/s. N.H.Langton and P.Vaughan.
Brit. J. appl. Phys., Vol. 8, No. 7, 289-92 (July, 1957).

Experimental results obtained by irradiating fractionated polystyrene in benzene with ultrasonics of 1 Mc/s frequency are given. Degradation is observed to take place, and the consequent variation of degree of polymerization P with length of time of irradiation is shown. The results are compared with those obtained by other workers who used lower frequencies, and discussed with reference to the degradation equation of Schmid. An alternative equation which fits the experimental results better is examined. A.

# DISPERSIONS. COLLOIDS. ADSORPTION 541.18

541.183

7480. SURFACE DIFFUSION OF HYDROGEN ON NICKEL.
R.Wortman, R.Gomer and R.Lundy.
J. chem. Phys., Vol. 26, No. 5, 1334-5 (May, 1957).

A field emission study. At any fractional coverage of the surface, migration occurs with an activation energy of ~7 kcal. The heat of desorption of $H_2$ from Ni was found to be 46 kcal for coverages $< 10\%$. A.B.Lidiard

541.183.26 : 537.312.5

ZINC OXIDE PHOTOCONDUCTION, AN OXYGEN ADSORPTION PROCESS. See Abstr. 7118

# CHEMICAL ANALYSIS 543/545

545.37

7481. RECORDING OXYGEN CONCENTRATION AND RATE OF EXCHANGE. F.S.Brackett, J.H.Daniel and R.G.Crickard.
Rev. sci. Instrum., Vol. 28, No. 3, 181-6 (March, 1957).

A recorder for oxygen concentration and rate of exchange is described. A polarographic square-wave method is adapted to servo-pen-recording. Cam-driven microswitches provide the square potential pattern and also the programmed timing on which the rate evaluation is based. A three-second time resolution in rate reveals transient details unobserved in concentration recording. A.

545.827

7482. ESTIMATION OF URANIUM AND THORIUM BY $\gamma$-SPECTROMETRY. P.Keller.
C.R. Acad. Sci. (Paris), Vol. 244, No. 6, 762-5 (Feb. 4, 1957).
In French.

Scintillation spectrometer measurements of the low-energy (RdTh/Io, Ra and ThB) $\gamma$-radiation of U- and Th- containing minerals allows a quantitative (±3-4%) estimation of the U and Th content. A.O.Stanesby

545.844

7483. AN IMPROVED AUTOMATIC FRACTION COLLECTOR.
G.F.H.Box and R.B.Bradbury.
J. sci. Instrum., Vol. 34, No. 5, 183-4 (May, 1957).

A fraction collector for chromatography is described which incorporates a new type of liquid dispenser, photoelectrically operated, and capable of delivering predetermined, fixed volumes despite variations in rate of outflow from columns, and changes in density of the liquid. A.

# CRYSTALLOGRAPHY 548

548.24 : 539.373

7484. THE DYNAMICS OF TWINNING AND THE INTER-RELATION OF SLIP AND TWINNING IN ZINC CRYSTALS.
R.L.Bell and R.W.Cahn.
Proc. Roy. Soc. A, Vol. 239, 494-521 (April 9, 1957).

The critical shear stresses for twinning in crystal wires with the basal plane nearly parallel to the wire axis were abnormally high and depended on the specimen dimensions. In all cases slip occurred on the $(11\bar{2}2)$ plane in the $[\bar{1}\bar{1}23]$ direction before twinning and the accompanying work-hardening determined the twinning stress. It is proposed that a twin nucleus, 250 A diameter, is formed by homogeneous lattice shear where the applied stress is magnified by an array of dislocations; nucleation occurring at a stress depending on the slip characteristics of the specimen. Basal slip in twinned crystals was accompanied by work-softening and occurred at higher stresses than normal basal slip. The stress to thicken existing twins was less than that to produce twinning. J.E.Caffyn

548.5 : 537.533.2

7485. FIELD EMISSION FROM MERCURY WHISKERS. R.Gomer.
J. chem. Phys., Vol. 26, No. 5, 1333-4 (May, 1957).

Hg whiskers were grown on a W substrate in a field-emission microscope. The whiskers were generally 110 oriented (f.c.c. pseudosystem), 0.1 mm long and $10^{-6}$ cm (diameter, their breaking strength was ~ $10^7$ $gm/cm^2$. Nucleation sites may be breaks in the oxide layer on the W surface, growth was exponential indicating diffusion of Hg from the sides to a screw dislocation at the tip of the whisker. J.Franks

548.52

7486. CAPTURE OF IMPURITIES DURING CRYSTALLIZATION.
J.Pauly.
Ann. Phys. (Paris), Ser. 13, Vol. 1, 1003-40 (Nov.-Dec., 1956).
In French.

The distribution coefficient (k) of foreign ions included during crystallization of $KNO_3$ from aqueous solution and from the melt was measured by radioactive tracer techniques. In growth from solution, k is small for alkaline cations ($10^{-3}$) except for Rb (0.24); k decreases slowly with increasing cation charge. In growth from the melt, $0.1 < k < 1$ for alkaline cations, k decreases with increasing $Sr^{++}$ concentration. The k-values for anions in solution are of the same order as those for cations ($10^{-3} - 10^{-4}$). J.Franks

548.52

7487. ON GROWING ARTIFICIAL QUARTZ CRYSTALS. J.Nagy and I.Tarján.
Acta phys. Hungar., Vol. 6, No. 3-4, 485-8 (1957). In German.

Quartz crystals were grown by seeding from solution in 5% $Na_2CO_3$ + 0.4% KOH, under pressures from 40 to 1800 atmospheres, and temperatures between 260 and 520° C. The best results were obtained in the temperature range 370-410° C under high pressure (with 70-80% of autoclave filled). J.Franks

548.52

7488. THE STUDY OF EPITAXY IN THIN SURFACE FILMS. D.W.Pashley.
Advances in Phys., Vol. 5, 173-240 (April, 1956).

Epitaxy was defined by Royer (1928) to denote the phenomenon of oriented growth of one crystal upon another. The phenomenon occurs in naturally occurring crystal specimens and can be observed in the laboratory when one crystalline material is deposited on another. The process is usually observed by depositing a thin film by chemical means or by vacuum evaporation on to a known crystal plane of the substrate. Epitaxy can be studied by means of the optical microscope, X-ray diffraction, and electron diffraction. This article deals mainly with the advances that have come about as a result of the latter of these methods. It has provided evidence of many new systems of oriented overgrowth and has helped explain the mode of growth of the initial nuclei of an oriented deposit. Critical examination of the original (1933) experimental data and recent experiments have failed to find any confirmation of the hypothesis of basal plane pseudomorphism. The pseudomorphic monolayers required by the (1949) theory of Frank and van der Merwe in explaining the overgrowth do not form in many cases. Directions in which further experiments would help solve the many outstanding problems and the limits of existing examination techniques are discussed. 171 references. C.A.Hogarth

548.52 : 537.228.1

7489. GROWING ETHYLENE DIAMINE TARTRATE CRYSTALS. P.G.Pozdnyakov.
Kristallografiya, Vol. 1, No. 2, 228-34 (1956). In Russian.

The technique of growing the crystals is described. A new method of mounting and orientating the seed crystal leads to practically homogeneous crystals. R.F.S.Hearmon

548.57

7490. PRODUCTION OF SINGLE CRYSTALS OF BARIUM TITANATE. H.Eustache.
C.R. Acad. Sci. (Paris), Vol. 244, No. 8, 1029-31 (Feb. 18, 1957). In French.

The solubility of $BaTiO_3$ in KF at temperatures between 840 and 1044° C was determined. Above 1000° C crystallization of $BaTiO_3$ is dendritic in nature, below 950° C cubes are obtained, and crystals can be grown by seeding. J.Franks

# ATOMIC AND X-RAY CRYSTALLOGRAPHY

## 548.7

548.7

7491. THE POTENTIAL ENERGY AND THE ELASTICITY OF A CRYSTALLINE MEDIUM. J.Laval.
Bull. Soc. Franç. Minéral. Crist., Vol. 80, No. 1-3, 18-31 (Jan.-March, 1957). In French.

A general treatment of the relation between elastic energy and interatomic forces: these forces being of a kind which cannot be expressed simply as a function of distance between a pair of atoms. See also Abstr. 1511 (1954). A.R.Stokes

548.7

7492. THE CALCULATION OF THE MATRIX COMPONENTS OF ENERGY FOR HEXAGONAL CLOSE-PACKED STRUCTURE. M.Miąsek.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 4, No. 12, 805-10 (1956).

548.7

7493. CALCULATION OF THE SURFACE ENERGIES OF ALKALI HALIDE CRYSTALS. F.van Zeggeren and G.C.Benson.
J. chem. Phys., Vol. 26, No. 5, 1077-82 (May, 1957).

Rapidly converging lattice sums for the electrostatic and van der Waals contributions to the surface energy of a generalized sodium chloride crystal have been derived. As special cases numerical values of these sums for the {100} and {110} faces of a NaCl-type crystal and for the {110} face of a CsCl-type crystal were computed. Surface energies for {100} faces of NaCl-type alkali halides and for {110} faces of both NaCl- and CsCl-type alkali halides have been calculated. A.

548.7

7494. MADELUNG CONSTANTS OF SOME CUBIC CRYSTALS. G.C.Benson and F.van Zeggeren.
J. chem. Phys., Vol. 26, No. 5, 1083-5 (May, 1957).

A simple method for evaluating the Madelung constant of a CsCl-type crystal is described. The Madelung constants of $CaF_2$-type and ZnS-type lattices are computed to ten decimal places from linear relations between the Madelung constants of these and NaCl- and CsCl-type crystals. A.

548.7

7495. INVESTIGATION OF THE FORM OF THE POTENTIAL CONTOUR FOR IONS IN PEROVSKITE TYPE CRYSTALS. L.N.Sȳrkin.
Kristallografiya, Vol. 1, No. 3, 274-86 (1956). In Russian.

The potential energy for small displacements of ions in a crystal is calculated from the elementary law of mutual interaction. The form of the potential contour is investigated for some crystals, and numerical formulae appropriate to barium titanate are derived. R.F.S.Hearmon

548.7 : 536.631

7496. SPECIFIC HEAT OF A THREE-DIMENSIONAL LATTICE OF OSCILLATORS. Y.Ayant, B.Dreyfus and J.Peretti.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1898-900 (April 1, 1957). In French.

By using a special analytical device it is shown that a low temperature expansion of the lattice thermal energy in powers of T can be found without an explicit calculation of the spectrum. The work applies to rather specialized systems, e.g. a simple cubic lattice with nearest neighbour interactions. It is concluded that for such systems the effective Debye $\Theta$ always decreases initially ($\Theta$ (T) = a − $bT^2$ + ... with b > 0) but that $\Theta$ (∞) may be greater or less than $\Theta$ (0). R.O.Davies

548.7

7497. STUDY OF THE ORDER–DISORDER TRANSFORMATION IN THE LITHIUM FERRITE $FeLiO_2$. R.Collongues.
Bull. Soc. Chim. France, No. 2, 261-3 (Feb., 1957). In French.

Heating of the ferrite at about 400° C produces an ordered tetragonal structure (a = b = 4.07 A, c = 4.28 A) similar to that of CuAu. The structure is compared with that (also tetragonal) known to be produced by heating at 600° C. E.P.Wohlfarth

548.7

7498. ORDER–DISORDER. R.Collongues.
Bull. Soc. Chim. France, 1957, No. 2, 265-9 (Feb.). In French.

A brief review of superlattice formation in alloys and chemical compounds. 20 references. E.P.Wohlfarth

548.7

7499. ON THE POLARON REST ENERGY AND EFFECTIVE MASS. G.R.Allcock.
Advances in Phys., Vol. 5, 412-51 (Oct., 1956).

The assembly of a slow electron, moving in the conduction band of an ionic crystal and in equilibrium with the self-induced polarization field, together with the field, is known as a polaron. The paper reviews the mathematical problems associated with the polaron and in particular the wave-function, energy and effective mass. Two kinds of polarization are distinguished, that produced in the electronic structure of the ions of the lattice and having characteristic frequencies in the ultraviolet, and that produced by the ions of the positive and negative lattices oscillating against each other and having characteristic frequencies in the infrared. The high and low frequency limiting cases have been worked out but apart from recent work by Feynmann and by Höhler, the intermediate range has not been investigated. In the present review the Hamiltonian, equations of motion, and quantization rules are stated for the polaron problem, and solutions for the various frequency ranges are given. C.A.Hogarth

548.7 : 539.11

7500. THE ENERGY BAND STRUCTURE OF THE METALLIC COPPER. THE ORTHOGONALIZED PLANE WAVE METHOD. M.Fukuchi.
Progr. theor. Phys., Vol. 16, No. 3, 222-30 (Sept., 1956).

The electronic band structure in the metallic copper is worked

out by the orthogonalized plane wave method in which the crystal potential is constructed by using both the Hartree's self-consistent field of $Cu^+$ ion cores with exchange and conduction electrons and the Slater's approximate exchange potential. The approximate energy versus $\vec{k}$-curve is obtained, which shows the strong resemblance to the free-electron behaviour along three directions in $\vec{k}$-space, i.e. (1.0.0), (1.1.1) and (1.1.0). The results of the various methods of approximation are compared with the results obtained by the author. A.

548.7 : 539.132

7501. ZEEMAN EFFECT ON THE QUADRUPOLE SPECTRA OF SODIUM, POTASSIUM, AND BARIUM CHLORATES.
H.Zeldes and R.Livingston.
J. chem. Phys., Vol. 26, No. 5, 1102-6 (May, 1957).

All features of the Zeeman pattern of $NaClO_3$ that were examined can be deduced from the crystal symmetry and knowledge of the orientation of the crystal axes in the magnetic field. The crystal axes could be located with respect to the magnet goniometer to within $0.05^0$ by observation of the Zeeman pattern. The line width was found to be 1.2 kc/s between flexes. A method was devised for orienting $KClO_3$ and $Ba(ClO_3)_2.H_2O$ crystals by attaching a $NaClO_3$ crystal and observing its Zeeman pattern. In $KClO_3$, the field gradient tensor asymmetry parameter $\eta$ was found to be about 0.006 and the z principal axis was located and compared with features of the structure. The line, one of the sharpest yet observed, measured 0.29 kc/s between flexes. In $Ba(ClO_3)_2.H_2O$, the upper limit for $\eta$ was found to be 0.05. The z principal axes were located and compared with features of the crystal structure. The line width was found to be about 3 kc/s. A.

548.7

7502. SOME PHYSICAL PROPERTIES OF DIAMONDS.
F.C.Champion.
Advances in Phys., Vol. 5, 383-411 (Oct., 1956).

Recent work on the optical and electrical properties of diamond is reviewed, analysed and compared with theoretical prediction in terms of lattice defects. Defect theory is developed in detail. Diamonds are classified according to their defects by comparison with the data on: (1) infrared absorption, (2) ultraviolet cut-off, (3) thermal conductivity, (4) counting, (5) photoconductivity, (6) electrical conductivity. Varieties of vacant sites, dislocations, interstitial atoms and foreign atoms are discussed. Growth-phase diagrams are considered. S.Tolansky

548.7 : 539.21

STUDY OF DEFECTS IN SOLIDS FROM RADIATION DAMAGE. See Abstr. 7443

548.73/.74

X-RAY AND ELECTRON INVESTIGATION OF MATERIALS. See also under "Structure of solids". Decimal classification 539.26/.27

548.73

7503. X-RAY DIFFRACTION STUDIES ON PRECIPITATES AND INCLUSIONS IN STEELS USING AN EXTRACTION REPLICA TECHNIQUE. G.R.Booker, J.Norbury and A.L.Sutton.
Brit. J. appl. Phys., Vol. 8, No. 4, 155-7 (April, 1957).

A simple extraction method is described in which precipitates and inclusions in steels can be isolated for identification by X-ray diffraction. The included material is removed from the metal surface embedded in a thin plastic replica, which is then formed into a small, compact, cylindrical specimen suitable for powder cameras. The scope of the method is discussed, and examples of the application of the method are given. Because the extraction period is only a few minutes, the method has several advantages over bulk extraction methods. In addition to the more stable constituents, iron carbide, iron nitrides and metal sulphides have been successfully extracted. A.

548.73

7504. COMMENTS ON THE A.S.T.M. POWDER DATA FILE.
J.W.Hughes, I.E.Lewis and A.J.C.Wilson.
J. sci. Instrum., Vol. 34, No. 5, 211 (May, 1957).

548.73 : 548.74 : 539.27

DIFFRACTION STUDIES OF 7% CHROMIUM–MOLYBDENUM STEELS. See Abstr. 7455

548.732

7505. GEOMETRY OF THE DIFFRACTION PICTURE IN DYNAMIC INTERACTION OF X-RAYS WITH CRYSTALS.
I.V.Yavorskiĭ.
Kristallografiya, Vol. 1, No. 3, 287-90 (1956). In Russian.

Theoretical. The probability of occurrence of secondary maxima increases with decreasing wavelength owing to the increasing number of nodes in the reciprocal lattice.
R.F.S.Hearmon

548.734.3

7506. COLOUR TRANSPOSITION OF PHENOMENA IN THE INVISIBLE SPECTRAL REGION. POLYCHROMATIC LAUE PHOTOGRAPHS. J.Barraud and S.Barbezat.
Bull. Soc. Franç. Minéral. Crist., Vol. 80, No. 1-3, 1-17 (Jan.-March, 1957). In French.

A coloured Laue photograph is obtained by combining, subtractively, in three colours, photographs taken with 20 kV, 30 kV, and 50 kV "white" radiation. A.R.Stokes

548.735.4

7507. A SYNTHESIZER FOR TRIANGULAR WAVE FUNCTIONS.
D.McLachlan,Jr.
J. sci. Instrum., Vol. 34, No. 5, 201-3 (May, 1957).

Describes an optical analogue computer for summing the Fourier series necessary in computing electron densities of crystals from X-ray data. Aside from its cheapness and ease of handling, its main feature is that the patterns characteristic of the Bragg–Huggins masks are synthesized in the machine by turning a knob which turns in opposite directions two drums upon which are mounted sheets of banded transparent film. Since the projected patterns or fringes are very close to the photographic recording paper, the light scattering is slight. A.

548.736.1

7508. SIZES OF THE ATOMS AND IONS OF TRANSURANIUM ELEMENTS IN CRYSTALS. A.F.Kapustinskiĭ.
Kristallografiya, Vol. 1, No. 4, 382-92 (1956). In Russian.

Estimates of atomic radii are given for valencies from 2+ to 6+ and of covalent radii for valencies from 4+ to 6+ in the elements from uranium to mendelevium. See also Abstr. 2987 (1948).
R.F.S.Hearmon

548.736.3 : 539.219

X-RAY INVESTIGATION OF ALLOYS OF THE GERMANIUM–RHODIUM SYSTEM. See Abstr. 6636

548.736.4 : 538.245 : 621.318.12

7509. CRYSTALLINE STRUCTURE AND MAGNETIC PROPERTIES OF FERRITES HAVING THE GENERAL FORMULA $5Fe_2O_3.3M_2O_3$. F.Bertaut and R.Pauthenet.
Proc. Instn Elect. Engrs B, Vol. 104, Suppl. No. 5, 261-4, 265-6 (1957).

A general account of the magnetic properties and crystal structure is given, and it is shown that they are in accordance with Néel's ideas (Abstr. 9381/1954). A.R.Stokes

548.736.4 : 537.311.33

COMPOUNDS WITH DIAMOND-TYPE (CHALCOPYRITE) STRUCTURE. See Abstr. 7102

548.74

7510. AN EXTRACTION REPLICA METHOD FOR LARGE PRECIPITATES AND NON-METALLIC INCLUSIONS IN STEELS.
G.R.Booker and J.Norbury.
Brit. J. appl. Phys., Vol. 8, No. 3, 109-13 (March, 1957).

A replica method for electron diffraction work is described which enables large (up to 10 $\mu$ or so) precipitates and inclusions to be extracted from steels. There is no etching through the replica, and consequently weakening and staining of the film are avoided. In addition to more stable constituents, included material normally dissolved by bulk extraction methods has been successfully extracted. Examples of the extraction of iron nitride, iron carbide, and non-metallic inclusions are given. A.

548.74

7511. THE DIFFRACTION OF ELECTRONS BY VERY SMALL METALLIC CRYSTALS. L.Lafourcade and P.Larroque.
C.R. Acad. Sci. (Paris), Vol. 244, No. 2, 178-80 (Jan. 7, 1957). In French.

Electron diffraction photographs, taken on the same photographic plate, of films of the same metal of very different thickness, show that the relative displacements of the diffraction maxima appear

to depend only on the number of atoms contained in the crystal. This displacement is significant only for crystals containing at most some hundreds of atoms. J.Thewlis

548.74

7512. ELECTRON DIFFRACTION INVESTIGATION OF THE STRUCTURE OF THIN LAYERS OF CADMIUM SULPHIDE, SELENIDE AND TELLURIDE. S.A.Semiletov.
Kristallografiya, Vol. 1, No. 3, 306-10 (1956). In Russian.

By means of point electron diffraction photographs, the crystal orientations of layers of CdS, CdSe and CdTe deposited on mica and NaCl are determined. The orientations of the cubic and hexagonal modifications relative to one another are also determined. R.F.S.Hearmon

548.74 : 539.27

APPLICATIONS OF ELECTRON DIFFRACTION. See Abstr. 7456

# GEOPHYSICS 55

551.463 : 535.345

7513. THE ABSORPTION OF ULTRAVIOLET RADIATION BY IONS PRESENT IN THE SEA. J.Lenoble.
Rev. Opt., Vol. 35, No. 10, 526-31 (Oct., 1956). In French.

Measurements on solutions of $MgCl_2$, $CaCl_2$, $SrCl_2$, KCl, NaBr, $Na_2SO_4$, $NaHCO_3$, and NaCl are used to tabulate the molecular extinction coefficients and extinction coefficients in the concentrations present in seawater for $\lambda$ = 2500-4000 A. All show gradual increase of absorption in passing to shorter wavelengths. G.F.Lothian

## ATMOSPHERE. METEOROLOGY 551.5

551.510.535

7514. LUNAR TIDAL VARIATIONS IN THE $F_2$ REGION OF THE IONOSPHERE. S.S.Baral.
J. Technol. (Calcutta), Vol. 1, No. 2, 175-7 (Dec., 1956).

Note on analysis of foF2 and hpF2 data for quiet days for Calcutta for the period 1947-52. The amplitudes of the mean annual lunar semi-diurnal harmonic are 0.09 Mc/s and 2.50 km respectively. The phases of the two oscillations are almost in quadrature. G.M.Brown

551.510.535 : 523.7

7515. RELATIONS BETWEEN THE SUN AND THE IONOSPHERE.
Nature (London), Vol. 179, 804-6 (April 20, 1957).

Report of a geophysical discussion held at the Royal Astronomical Society, London, on February 22, 1957. Two topics were discussed at separate sessions: (1) the great solar flare of 23rd February 1956, and (2) the solar cycle variation of the sun's ionizing radiation. The main effects of the great solar flare on the light and dark sides of the earth were summarized. It was suggested that the ionospheric and cosmic-ray effects could be reconciled if the primary solar particles emitted by the flare were singly ionized He atoms. Estimates of the changes of the background and the slowly varying components of the ionizing radiation of the sun over a solar cycle show that they are roughly the same as the corresponding changes in 10 cm solar radio noise intensity. Similar correspondence is found for the distribution of intensities over the solar disk during an eclipse. G.M.Brown

551.510.535 : 519.24

7516. A STATISTICAL DISTRIBUTION ARISING IN THE STUDY OF THE IONOSPHERE. M.S.Longuet-Higgins.
Proc. Phys. Soc. B, Vol. 70, Pt 6, 559-65 (June, 1957).

An approximate distribution is deduced for the directions of the "lines of maxima" on a random surface. The theoretical distribution is found to be in good agreement with some experimental results obtained previously by Briggs and Page. A.

551.510.535

RADIO-WAVE PROPAGATION IN THE IONOSPHERE. See also under "Electromagnetic waves and oscillations". Decimal classification 538.566.3

551.521.1 : 536.722

7517. THE CONVERSION OF RADIATIONS INTO ELECTRICITY. V.B.Veĭnberg and Yu.V.Mal'tsev.
Zh. tekh. Fiz., Vol. 26, No. 10, 2373-7 (1956). In Russian.

Whilst there have been many discussions of the thermodynamics of converting (solar) radiation into heat and thence into electrical energy the thermodynamics of the processes occurring in the heater where the incident radiation is trapped is not normally considered in detail. The paper, which is theoretical, considers the optimal conversion conditions taking into account the parameters relative to the heater. The characteristics of various types of solar heater in optimal working conditions are given in tabular form. For Central Asia summer conditions the daily power generation per square metre is 100-150 Whr; with reflectors 2 kWhr can be achieved. Thermoelectric installations may give only $\frac{1}{4}$ to $\frac{1}{3}$ of this energy. C.R.S.Manders

551.521.326

7518. OBSERVATIONS OF THE NOCTURNAL ATMOSPHERIC LUMINESCENCE FROM THE RED LINE OF OXYGEN. D.Barbier.
C.R. Acad. Sci. (Paris), Vol. 244, No. 13, 1809-11 (March 25, 1957). In French.

A detailed description of the characteristic nocturnal variations of intensity of the O I nightglow at 6300 A. Systematic nightly observations were made by sweeping the entire horizon at a fixed zenith distance of 75 degrees. Qualitatively at least, the general pattern of luminescence is reproducible from night to night, and from one season to another. D.R.Barber

551.521.326

7519. AN INTERPRETATION OF THE NOCTURNAL LUMINESCENCE OF THE RED OXYGEN LINE. D.Barbier.
C.R. Acad. Sci. (Paris), Vol. 244, No. 15, 2077-80 (April 8, 1957). In French.

An empirical formula, $I = 5.83 \times 10^5 f_0^2 e^{-(h' - 200)/88}$, is established to relate the nocturnal intensity of the OI line at 6300 A, (I), with the critical frequency of the ionospheric F-layer, ($f_0$), and its equivalent height (h'). Experimental results show very good agreement between the above parameters for the first part of the night. Later, however, a modified emission pattern appears and spreads from the N to cover the entire hemisphere of sky. The previously observed correlation is now masked, suggesting that the ionization pattern at the F-level is not similarly modified. The change in the emission pattern is explained as the probable result of an ingress of less-dissociated air originating in high latitudes ("arctic air"). A similar inflow has been postulated by Seaton (1955) to account for the disappearance of the F-layer during intense aurorae. D.R.Barber

551.521.326

7520. PHOTOELECTRIC OBSERVATIONS OF ANOMALOUSLY POLARIZED TWILIGHT EMISSION AT 5893 A. D.R.Barber.
J. atmos. terrest. Phys., Vol. 10, No. 3, 172-6 (March, 1957).

On a number of occasions during the last sunspot cycle, following flare, and M-region activity, predominantly polarized emission from a narrow waveband (half-intensity width, 260 A) centred at the Na D lines was observed in twilight with a photoelectric polarization photometer at effective (optical) sounding heights of between 35 and 65 km. The anomaly first appears ~55 hr after the flare, or corpuscular disturbance leaves the sun, and reaches max. development from 25 to 45 hr later, after which a slow recovery to normal conditions ensues for a further 5 to 6 days. The duration of the polarized emission varies with sounding height from ~50 hr at 35 km to ~250 hr at 65 km. It is not yet certain whether the effect is confined to the Na D lines alone, or to other atmospheric emissions within the waveband observed; and the exact cause of the highly polarized emission is not known. D.R.Barber

551.594.5

7521. PHOTOELECTRIC OBSERVATION OF AURORAL ACTIVITY AT LOW LATITUDES. D.Barbier.
C.R. Acad. Sci. (Paris), Vol. 244, No. 14, 1945-7 (April 1, 1957). In French.

Account of observations of aurorae, invisible to the naked eye,

at geomagnetic latitude 45.7°, by the use of a new photometer which confines study to the 6300 Å ray of oxygen. G.M.Brown

551.594.5

7522. THE FREQUENCY DEPENDENCE OF RADIO REFLECTIONS FROM AURORA. P.A.Forsyth and E.L.Vogan.
J. atmos. terrest. Phys., Vol. 10, No. 4, 215-28 (1957).

Auroral radio-reflections have been observed at a number of frequencies between 30 and 50 Mc/s using continuous-wave transmitters located at a distance of 860 km from the receivers. The relative amplitudes of signals observed simultaneously at the different frequencies are found to vary widely. The experimental results are compared with those which would be expected for each of five different scattering mechanisms which have been proposed to explain auroral reflections. It is concluded that within small regions of the aurora the ionization is often sufficiently intense to cause complete reflection at these frequencies. Some evidence is presented which indicates that absorption may contribute significantly to the observed frequency dependence. A.

# BIOLOGY 57/59

## MEDICAL SCIENCE. HUMAN PHYSIOLOGY

### 61

612.85

7523. CONTRIBUTION TO THE STUDY OF THE ARTIFICIAL EAR PROBLEM. THE NEW ARTIFICIAL EAR OF THE CENTRE NATIONAL D'ÉTUDES DES TÉLÉCOMMUNICATIONS. P.Chavasse.
C.R. Acad. Sci. (Paris), Vol. 244, No. 15, 2014-17 (April 8, 1957). In French.

A section and a plan of the new artificial ear, and comment on the method of measurement, are given. For the same earphone, the sound pressures in the human and in this artificial ear differ by less than 1 dB. H.D.Parbrook

# TECHNIQUE. MATERIALS 62/69

66.041 : 539.213.2

7524. A HIGH TEMPERATURE MICROFURNACE FOR THE STUDY OF THE DEVITRIFICATION OF GLASS. H.Bridge.
J. sci. Instrum., Vol. 34, No. 4, 135-9 (April, 1957).

The construction and operation of a microfurnace designed to combine a low thermal capacity with accurate temperature measurement is described. The specimen, which is approximately 1.5 mm in diameter, may be raised to a temperature of 1200°C in less than one minute and maintained to within ± 2 deg. C of the working temperature for several hours. For general work the specimen is viewed with a ×5 objective, though a ×10 objective, with a numerical aperture of 0.25, may be used for continuous observation up to 1000°C and for shorter periods at higher temperatures. In the instrument described the specimen is exposed to the air but conversion for work in a controlled atmosphere would be relatively simple. Though primarily designed for the study of crystal growth from the melt, and the rapid delineation of phase equilibria diagrams, the apparatus has been applied to the study of the growth of single crystals, melting-point determinations and the investigation of phase precipitation in opal glasses. Special attention has been given to the photographic recording of experiments and an example of rate of crystal growth measurement using this technique is given. A.

66.048

7525. NEW LOW-HOLDUP HIGH-EFFICIENCY LABORATORY DISTILLATION COLUMN. J.D.Ray.
Rev. sci. Instrum., Vol. 28, No. 3, 200-1 (March, 1957).

A new type distillation column similar to a Vigreau column is described which has the indentations perpendicular to the wall of the tube. It was found that the indentations gave optimum performance if at an angle of 90° to the axis of the column. A jig is described which facilitates making indentations in glass tubing so as to result in a high precision of indentation spacing. A.

669 : 548.53

7526. ON THE MATHEMATICAL THEORY OF ZONE-MELTING. I.Braun and S.Marshall.
Brit. J. appl. Phys., Vol. 8, No. 4, 157-62 (April, 1957).

A complete solution is presented of the equations governing the redistribution of solutes in zone-melting processes. The effect of "normal freezing" in the last zone-length of a bar is treated rigorously. The solutions hold for all values of the distribution coefficient. Numerical calculations have been made of the concentration profiles resulting from repeated zone-melting, and specimen graphs are given. A.

669 : 548

7527. THE FLOATING-ZONE MELTING OF REFRACTORY METALS BY ELECTRON BOMBARDMENT.
A.Calverley, M.Davis and R.F.Lever.
J. sci. Instrum., Vol. 34, No. 4, 142-7 (April, 1957).

An apparatus which produces floating liquid zones in vertical rods of refractory metals is described. Movement of the zone along the specimen can purify it in three ways, namely, outgassing on vacuum fusion, evaporation of volatile impurities, and segregation of impurities in the liquid zone. Traversing speeds of approximately 1 cm/min have been used and the vacuum maintained between $10^{-5}$ and $5 \times 10^{-4}$ millibar. Power requirements are about 400 W or less. There is a theoretical upper limit of approximately 1 cm on the diameter of a specimen and a practical size limit on its length. Specimens as low as 2 mm in diameter have been zoned. After zoning, many specimens are found to be single crystal. A

681

7528. THE ECCENTRIC LOADING OF OPTICAL FLATS DURING GRINDING. N.F.Barber; N.J.Rumsey.
J. sci. Instrum., Vol. 34, No. 1, 36 (Jan., 1957).

An experiment in grinding a rectangular slab of glass suggested that grinding does not take place over the whole surface if the pressure is applied too far from the geometrical centre. The numerical conclusions are criticized by Barber who claims that the result is a proof that the rate of removal of glass is proportional to the pressure applied. Rumsey replies on the validity of his deductions and points out that a different result could provide a test for abnormality of materials. E.G.Martin

# PHOTOGRAPHY 77

77.03

7529. EFFICIENT USE OF A PICTURE CORRELATOR.
M.Horowitz.
J. Opt. Soc. Amer., Vol. 47, No. 4, 327 (April, 1957).

This instrument is a device for measuring the amount of light passing through two photographic films as one slides past the other. The similarity between the two pictures is measured by a correlation method; in general six readings are required, but under certain (stated) conditions, for black and white pictures, two readings will suffice. N.Corcoran

771.3 : 551.594.5

7530. A FAST AURORAL CAMERA. R.Montalbetti.
Canad. J. Phys., Vol. 35, No. 3, 280-3 (March, 1957).

A movie camera is described which photographs an auroral display at a speed of one or more frames per second. The fast optical system and wide angular field of view are obtained with an f/0.71 objective and a spheroidal mirror. The camera has been found very useful in the study of auroral motions. A.

771.319

7531. THE OPERATION OF A MINIATURE CAMERA BY REMOTE CONTROL. D.E.Blackwell and D.W.Dewhirst.
J. sci. Instrum., Vol. 34, No. 7, 274-6 (July, 1957).

The difficulties encountered in devising a mechanism for automatically winding and releasing the shutter of a Contax camera are discussed. A suitable clutch mechanism, found to be satisfactory, is described. A.

771.53

7532. RELATION BETWEEN GRANULARITY AND AUTOCORRELATION. II. E.Pitts and A.Marriage.
J. Opt. Soc. Amer., Vol. 47, No. 4, 321-6 (April, 1957).

For Pt I, see Abstr. 3876 (1957). A general equation is derived which gives the root-mean-square transmission (and hence the granularity) as an integral of the product of the autocorrelation and an "aperture weighting function". A method using expansion into series is described which inverts this equation and gives the autocorrelation in terms of the root-mean-square transmission. Solutions in closed form have been obtained for two special cases of physical importance to which the series solutions are shown to be equivalent. In view of this interconvertibility, the choice of optical systems for making measurements which will correlate well with visual graininess is a matter of practical convenience in obtaining the relevant parameters. A.

771.53 : 535.3

7533. A CONTRIBUTION TO THE STUDY OF THE FORMATION OF A PHOTOGRAPHIC IMAGE FROM AN OPTICAL IMAGE.
M.Marquet.
Rev. Opt., Vol. 36, No. 2, 53-70 (Feb., 1957). In French.

Measurements have been taken of images of simple line test charts formed by contact printing through a wedge. These show that the image can be calculated from the sensitometric properties of the film by assuming an effective intensity distribution in the optical image. The effective distribution is found to be additive, so that the photographic image can be calculated for more complex line-structures. The effect of normal and more prolonged development times is considered. R.W.Fish

778.34

7534. STUDY OF THE DIFFUSION OF $\alpha$-EMITTING TRACER IONS IN WET NUCLEAR EMULSIONS. R.Desprez.
Ann. Phys. (Paris), Ser. 13, Vol. 1, 779-807 (Sept.-Oct., 1956).
In French.

A stripped nuclear emulsion (C2, 200 $\mu$thick, 19 x 37 mm$^2$), soaked in distilled water for two hours, was sandwiched between two similar wet glass-backed emulsions and dipped edge-on into a solution of sodium uranyl carbonate for two and a half hours. After processing, the variation in the number of $\alpha$-tracks was measured as a function of height up to 6 mm, the total being 5072. Fick's law is confirmed to 1% and the value of the diffusion coefficient D is found to be $(30.68 \pm 0.40) \times 10^{-7}$ cm$^2$ sec$^{-1}$. An earlier, less precise, experiment is also described. Contains review of previous work and 30 references. E.J.Burge

778.34

7535. THE TIME-DEPENDENCE OF THE RECORDING PROPERTIES OF G5 NUCLEAR EMULSION.
W.C.Barron and A.W.Wolfendale.
Brit. J. appl. Phys., Vol. 8, No. 7, 297-300 (July, 1957).

The fading of fast proton and $\mu$-meson tracks in G5 nuclear emulsion has been studied as a function of time and conditions of storage. The storage time for a 50% reduction in the blob density of the tracks is estimated to be 1040 ± 200 days for storage at 5°C and 520 ± 50 days at 25°C. No difference in fading has been found between the emulsions stored in air and those stored in commercial argon. The mechanism responsible for the fading appears to be the thermal ejection of electrons from the latent image. The sensitivity of the emulsion after storage has also been studied. A reduction in blob density of the tracks of fast particles of less than 5% after a storage time of 450 days has been found. A.

778.34

7536. ON THE PREPARATION OF "NUCLEAR" PHOTOGRAPHIC EMULSIONS WITH SILVER CHLORIDE.
H.Gauvin and W.Sebaoun.
C.R. Acad. Sci. (Paris), Vol. 244, No. 11, 1489-92 (March 11, 1957).
In French.

The preparation and use of nuclear emulsions containing AgCl instead of AgBr is discussed. Such emulsions have been successfully poured and their characteristics have been examined. These are now sufficiently good for general use in nuclear physics when interactions with medium-heavy nuclei such as Cl are desired.
D.J.A.Prowse

778.34 : 621.374.32

7537. A TIME SCALER FOR NUCLEAR TRACK LENGTH MEASUREMENTS. K.Enslein.
Electronic Engng, Vol. 29, 277-81 (June, 1957).

The instrument described, generates under semi-manual control the distribution function of nuclear track lengths by converting lengths to time intervals. It is based on straightforward circuits using glow tubes and coincidence circuits for timing with electromechanical registers for indication. The resolving time of the present instrument is of the order of 100 msec, but can be decreased to any desired value by the incorporation of a suitable time-base. A.

778.34

7538. ON A STATISTICAL PROBLEM IN EMULSION MICROSCOPY. H.Olsen, H.Wergeland and H.Øverås.
K. Norske Vidensk Selsk. Forhandl., Vol. 28, No. 6, 25-9 (1955).

The probability distribution of the ordinate of a curve, the derivative of which has a continuous Brownian motion distribution, is obtained. It is suggested that this result may have applications in the theory of ionization tracks in emulsions. N.L.Johnson

778.34

7539. ON THE PHOTOGRAPHIC DETECTION OF IONS IN THE MASS SPECTROGRAPH. E.Schönheit.
Naturwissenschaften, Vol. 44, No. 9, 278-9 (1957). In German.

Standard plates were sensitized by a fluorescent film (with a low vapour pressure), as an alternative, though less accurate, method to using special plates. Apiezon oil "F" was used. It was applied, dissolved in benzene, to several types of emulsion, increasing their sensitivities by factors up to 100. D.H.Lord

778.34

7540. MOVING-PLATE CAMERA FOR NUCLEAR RESEARCH.
W.K.Dawson and B.W.Sargent.
Rev. sci. Instrum., Vol. 28, No. 5, 337-41 (May, 1957).

A moving-plate camera, suitable for investigating the angular and energy distributions of photoprotons, is described. Two nuclear plates, 1 x 3 in., are accurately held with the emulsion surfaces vertical, parallel and facing each other on a carriage, which moves forwards and backwards at constant speed below the target and parallel to the X-ray beam in an evacuated tube. Targets are thin metal foils, 1.5 x 1 in. The angles and energies of tracks recorded in each plate coated with 200-$\mu$ emulsion are 20° to 160° and approximately 2 to 16 MeV. The theory of the camera is developed in detail. A.

778.34

7541. ON THE NATURE OF THE CONE-LIKE SHAPE OF TRACKS OF MULTI-CHARGED IONS IN NUCLEAR EMULSIONS. O.V.Lozhkin.
Zh. éksper. teor. Fiz., Vol. 32, No. 2, 208-13 (1957). In Russian.

Photometric investigations of the tracks of multi-charged particles in fine-grained nuclear emulsions of various sensitivity indicate that the thinning down of the track near the end of the range is not due to variation of the total specific energy losses but to variation of the energy spent by δ-electrons with $E \geq 2$ keV near the track axis. A new method for measuring the total charge of multi-charged particles in fine-grained nuclear emulsions is described. A.

778.534.8 : 535.822.9

7542. ULTRA-HIGH-SPEED FLASH CINEMICROGRAPH. J.S.Courtney-Pratt and C.M.Huggins.
Rev. sci. Instrum., Vol. 28, No. 4, 254-5 (April, 1957).

The principles of Cranz—Schardin flash cinematography are described. This method uses up to thirty separate lenses and air sparks to produce an equivalent number of "still" photographs. The framing rate and exposure times are determined by the characteristics of the light sources; framing rates of over one million per second have been reported. A modified version of the Cranz—Schardin camera which uses only one microscope objective lens and eight air sparks to produce eight micrographs is described. The performance to be expected and some possible applications are discussed. A.

778.534.8 : 535.822.9

7543. CONSTRUCTION AND PERFORMANCE OF A HIGH-SPEED CINEMICROGRAPH. J.S.Courtney-Pratt and C.M.Huggins.
Rev. sci. Instrum., Vol. 28, No. 4, 256-62 (April, 1957).

The cinemicrograph described is capable of producing a series of 200 pictures at 100 000 frames per second. The basic principle of this "image-disecting" camera consists of reproducing each scene in half-tone (i.e., breaking the picture up into an array of widely-spaced dots) and interspersing succeeding frames on the same composite plate by moving the plate one dot diameter between successive frames. After processing, the frames are "played back" in sequence. The technique of image dissection is further improved by the use of a plate of small, spherical lenslets to produce the dot structure. This advance considerably increases the light-gathering power and ultimate top speed of the camera, making it possible to do high-speed cinemicrography using a commercial Vickers projection microscope for magnifications up to 2000 x with various illumination techniques. The cine record so produced is of quite high quality; each frame conveys about the same information as a standard 16 mm cine frame. Some examples of "movie" scenes are shown for visual comparison. A.

# LIST OF JOURNALS

The following list supplements the List of Journals published with the June number of Volume 60 (1957). Reprints of this List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Astron. Zh.
Astronomicheskiĭ Zhurnal — "Akademknigo", ul. Kuĭbysheva 8, Moscow.

Pribory i Tekh. Éksper.
Pribory i Tekhnika Éksperimenta — Mezhdunarodnaya Kniga, Moscow.

Trans Bose Res. Inst. Calcutta
Transactions of the Bose Research Institute, Calcutta — 93/1 Upper Circular Road, Calcutta 9.

## NEW JOURNALS

Acta tech. (Prague)
Acta technica — Československá Akademie Věd, Národní tř. 5, Prague I.
Vol. 1, No. 1, dated 1956.

Ann. Phys. (New York)
Annals of Physics — Academic Press, 111 Fifth Avenue, New York 3, N.Y.
Vol. 1, No. 1, dated April, 1957.

## NOTES

Elect. Engr (Melbourne)
Electrical Engineer — Title changed from: Electrical Engineer and Merchandiser [Elect. Engr. Merch.] starting with Vol. 34, 1957.

J. Electronics and Control
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# ERRATA

Abstr. 5885 (1957) line 6 : for "multiplier" read "multiplied".
Abstr. 6408 (1957) line 12 : for "Mc/s" read "kc/s".

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